DOE/EH-413-0005

Environmental Restoration Waste Management Guide

July 2000

United States Department of Energy
Office of Environmental Policy and Guidance
RCRA/CERCLA Division (EH-413)

DOE/EH-413-0005

ENVIRONMENTAL RESTORATION WASTE MANAGEMENT GUIDE

JULY 2000

Prepared by
U.S. Department of Energy
Office of Environmental Policy and Guidance
RCRA/CERCLA Division (EH-413)

Technical Support by
Energetic, Incorporated
Project Performance Corporation

For Additional Information Contact:

Jerry Coalgate, EH-413
phone: 202-586-6075
fax: 202-586-3915
jerry.coalgate@hq.doe.gov

TABLE OF CONTENTS

LIST OF EXHIBITS

Chapter 1: Introduction

1.1 Background

Faced with continued pressure to meet enforceable schedules and reduce costs, Department of Energy (DOE) project managers continue to focus on how to plan and implement efficient and effective environmental restoration projects and how to avoid unanticipated circumstances that may lead to delays in project completion. Cost-effective management of wastes generated during restoration ("environmental restoration wastes") is an essential component to conducting these more efficient and effective cleanups.

Throughout this *Guide*, definitions, notes, and specific sources of additional information will be provided in this margin. An excellent general source of regulatory information is the Internet site maintained by DOE's Office of Environmental Policy and Guidance, EH-41, found at: http://www.eh.doe.gov/oepa.

The management of environmental restoration wastes, however, can be complex. There are numerous regulatory requirements governing how environmental restoration waste management activities must be conducted. Additionally, there are always uncertainties associated with waste management, some of which a project manager may not be able to eliminate prior to beginning actual environmental remediation work. To ensure such waste management activities remain in compliance with laws and regulations and do not impede project implementation, a project manager must be able to identify and manage major uncertainties that are associated with managing environmental restoration wastes.

This *Guide* incorporates EPA policies and rulemakings through December 1, 1999. EPA is considering other important rulemakings, such as modification to its corrective action management unit regulations, that could affect restoration waste management. Project managers must be aware of these types of policy changes to stay current on future rule changes.

Identifying proper management strategies for environmental restoration wastes is primarily driven by an adequate understanding of three factors: (1) what media type (e.g., soil, debris, ground or surface water) needs to be managed; (2) what are the key characteristics of contaminants found in the media (including type of waste, constituents present, concentration levels, and extent of contamination); and (3) what is the selected response action (e.g., what steps will occur to implement the action). Although investigations provide much of the information needed to plan waste management strategies, uncertainties will nearly always remain.

The purpose of this *Environmental Restoration Waste Management Guide* (or *Guide*) is to provide remedial project managers with information that may help facilitate better planning of waste management processes for projects subject to both the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Resource Conservation and Recovery Act (RCRA) Corrective Action program. It introduces a systematic approach that project managers can use to address waste management issues. This approach is based on the concept of uncertainty management, consistent with Department of Energy and Environmental Protection Agency's (EPA) principles of environmental restoration, *(Principles of Environmental*

Restoration Workshop, November 1997), and several EH-41 Principles of Environmental Restoration fact sheets. In addition, this *Guide* provides references and summaries of the major regulatory requirements that drive how waste management must be conducted, and the practical implications of those regulations on environmental remediation projects. This *Guide* complements, and is complemented by another recent EH-413 guidance document entitled **"Management of Remediation Waste Under RCRA, December 20, 1999,** which is found on the EH-41 website at: http://www.eh.doe.gov/oepa under "Policy and Guidance".

These EH-41 fact sheets include: *Uncertainty Management: Expediting Cleanup Through Contingency Planning*, *Expediting Cleanup Through Early Identification of Likely Response Actions*, and *Expediting Cleanup Through Problem Identification and Definition* (see "Policy and Guidance" on OEPA website).

1.2 Scope of Document

This *Guide* has a broader scope than that of "remediation wastes" because *remediation wastes*, as defined in RCRA (40 CFR 260.10), only refer to media contaminated with hazardous wastes. The RCRA definition (as amended in the HWIR-Media rule, 63 FR 65881, November 30, 1998) is:

> *All solid and hazardous wastes, and all media (including ground water, surface water, soils, and sediments) and debris, that contain listed hazardous wastes or that themselves exhibit a hazardous characteristic, and are managed for implementing cleanup.*

This is the Federal RCRA definition for remediation waste. States may expand on or make more stringent definitions under their delegated authorities and many States have done so.

Environmental restoration wastes, as discussed in this *Guide*, consist of a broader range of contaminated media such as radioactive waste and mixed radioactive and hazardous waste and other wastes such as PCBs and asbestos-containing wastes. This *Guide* discusses the management issues associated with major restoration wastes for each media in which they may be found (i.e., ground water, soil, and debris). Each of the waste types covered by this *Guide* are briefly defined in Exhibit 1-1.

DOE Order 435.1, *Radioactive Waste Management*, issued on July 9, 1999, replaced DOE Order 5820.2A. It defines requirements for managing transuranic (TRU) and low-level waste (LLW). It is found at: [http://www.explorer.doe.gov:1776/html/alldirectives.html].

Chapter 2: Systematic Environmental Restoration Waste Planning Approach

To meet the objectives of effective and efficient remediation actions, project managers need to conduct a systematic evaluation of key parameters of each waste stream that will be produced during environmental restoration projects. This approach is necessary for two reasons:

- First, an extensive number of requirements often apply to the management of environmental restoration wastes. Given the complexity of many of these requirements, systematic evaluation of each waste stream allows a project manager to ensure that environmental restoration waste management requirements do not hinder implementation of the desired response action.

- Second, even small differences among remediation alternatives (e.g., using different types of technologies to separate contaminants from a media) or small differences in what contaminants are present can lead to significant changes in how restoration waste streams must be managed. Project managers, therefore, need to understand likely restoration waste management requirements early in their projects, and identify and manage key uncertainties in these waste plans that, if encountered, may have significant cost or schedule impacts.

This chapter relies on use of the uncertainty management principle. More information can be found in *Uncertainty Management: Expediting Cleanup Through Contingency Planning*, (DOE/EH/(CERCLA)-002), and *Expediting Cleanup Through Early Identification of Likely Response Actions*. [http://www.eh.doe.gov/oepa under "Policy &Guidance"]

This chapter describes a systematic approach that project managers can use to conduct this analysis and outlines a process to manage the uncertainties that are inherent in handling environmental restoration wastes.

The basis for the systematic approaches outlined in this *Guide* is the use of principles of environmental restoration that the DOE and U.S. EPA have developed and promoted. In particular, two of the principles, (1) the importance and value of the early identification of appropriate response actions and (2) uncertainty management, are critical to understanding and implementing effective environmental restoration waste management. Two other principles, (1) establishment of an effective core team and (2) early problem identification, are also relevant, but not as central to effective management of environmental restoration wastes.

Uncertainty management focuses on identifying the likely conditions that will be encountered, deviations to those conditions, and evaluation of strategies to manage the possibility that those deviations will occur and the impacts if they do.

This chapter discusses each of these two principles and then describes how a simple planning matrix (tool shown in Exhibit 2-1, for use throughout the planning and execution of environmental restoration and facility disposition projects) can be beneficial for environmental restoration waste planning. Early identification of likely response actions, and the implementation of those responses as soon as sufficient site information is available to do so, can significantly decrease the costs and accelerate the schedules of environmental restoration projects by eliminating unnecessary engineering studies. Because environmental restoration waste planning depends in large part on the response action selected, early identification of probable response actions allows the project manager to assess which regulatory requirements the waste will likely be subject, and begin planning compliant waste handling methods. By focusing early on the response strategy, project managers also improve their ability to collect missing data efficiently.

The rest of this chapter and Chapter 3 provide some overall considerations about managing environmental restoration waste. Each media-specific chapter of the *Guide* that follows (i.e., Chapters 4 through 6) briefly identifies the likely response actions available (only for the purposes of identifying what residual waste streams the technologies likely will generate) and the specific requirements applicable to managing these residual wastes. This is necessary because early identification of these residual waste streams and their characteristics is the cornerstone of the systematic approach advocated in this *Guide*.

2.1 Systematic Uncertainty Management

2.1.1 Background

Uncertainty analysis, as discussed in this *Guide*, refers to the identification and evaluation of known and unknown conditions, the potential impacts on decision making of the unknown conditions, and evaluation of what, if any, additional data or contingency planning are needed to reduce the impacts of the uncertainty.

Uncertainty exists in nearly every aspect of an environmental restoration or facility disposition project. One major uncertainty is how wastes that will be generated during an environmental restoration project must be handled. Key elements of this uncertainty are often technical (e.g., what contaminants are present, what the depth of contamination is in soil), but also can be regulatory (e.g., will wastes have to meet RCRA land disposal restrictions) or programmatic (e.g., what funding is available if a more stringent set of regulatory obligations are triggered because of unanticipated wastes that were found).

Although a project manager may be able to identify the ***expected*** waste streams that will be generated during an environmental restoration project, the characteristics of these wastes, and which regulations will apply to these wastes, there is always a possibility that the ***actual*** waste types generated when a project is implemented *or* the characteristics of the waste may deviate from these expectations. If expected and actual conditions differ significantly, planned waste management approaches may not satisfy the actual set of regulatory requirements that are triggered. Moreover, if a project manager must significantly change waste management approaches to address unanticipated waste streams or their characteristics during a project, significant increases in cost and delays in schedule may result.

In this *Guide*, uncertainty analysis and management are processes to systematically evaluate and identify where it may be necessary to plan for circumstances that could differ from expected characteristics of environmental restoration waste streams. These processes also help to identify where differences are between expected and actual circumstances (e.g., an additional contaminant is present in a waste that was not anticipated) that could have major impacts because different regulatory requirements may apply.

2.1.2 Fundamentals of Uncertainty Management

Options for managing uncertainty:

- **Disregard uncertainty due to its insignificance.**
- **Eliminate or reduce the uncertainty by obtaining more information about whether expected circumstances are actual circumstances.**
- **Manage the uncertainty such that actual and expected circumstances are the same.**

Critical to uncertainty management is what options are available to project managers when inevitable uncertainties exist. Three options are available. For any uncertainty, a project manager may 1) disregard the uncertainty because it is judged to be insignificant; 2) attempt to eliminate or reduce the uncertainty by obtaining more information about whether expected circumstances are the actual circumstances (e.g., through additional data collection to determine exactly what waste types are present in a media); or 3) manage the uncertainty (e.g., through a contingent approach) such that if the actual and expected circumstances are not the same, a plan is already in place to address the situation.

To make a decision about which option is most appropriate given any particular uncertainty, a project manager should consider three factors.

1. ***The potential impact of the uncertainty.*** This impact depends both on the likelihood that a circumstance different from an expected circumstance exists and the impact that this difference would have on implementing the project. Some deviations between expected and actual conditions only may have a negligible impact. For example, if a listed hazardous waste is known to be present in soil that is to be excavated, the concentration of that contaminant will not determine or affect the determination of whether the waste is subject to RCRA or corresponding State hazardous waste regulations (because listed wastes are hazardous regardless of concentration).

Conversely, other types of unexpected circumstances may have a high impact on a project. For example, if a project manager expects ground water to be contaminated only with hazardous substances at a known concentration, he may plan to manage [i.e., extract, treat (if necessary), and discharge] extracted ground water under a National Pollutant Discharge Elimination

System (NPDES) permit. However, if radionuclides, an unexpected contaminant, are found in the waste stream during the implementation of the project, the project manager may no longer be able to discharge the ground water through a NPDES permit without first applying the best available technology for treating the radioactive component. This unanticipated circumstance could result in substantial cost and schedule increases or even preclude use of the planned discharge option.

2. ***The effectiveness of available contingency options.*** Although an uncertainty may have a potentially significant impact on a project, the project manager may determine that it is most appropriate (i.e., cost effective) to manage this uncertainty during implementation (e.g., develop a contingency plan) rather than reduce it up-front by collecting additional data. This is the case if a project manager determines that: (1) monitoring and contingency plans can easily minimize the impact of encountering unexpected conditions on project success; or (2) it is more cost-effective to resolve the uncertainty during implementation than through up-front characterization.

For example, the project manager may not know if the type and level radionuclides in soil will meet the definition of TRU waste. Rather than attempting to resolve this issue through data collection and analysis prior to implementation, the project manager may instead require that soil is analyzed in the field as it is excavated. If contamination is detected that would indicate that TRU wastes could be present, the project manager could then establish and implement a contingency plan to segregate this portion of the waste for further analysis and appropriate TRU-waste management. This approach has the potential to minimize up-front costs of data collection and still ensure that the waste management approach is compliant with applicable regulations.

3. ***The feasibility of reducing the uncertainty.*** In some cases, it is not feasible to resolve an uncertainty up-front and, therefore, it must be managed through a contingency plan. For example, in excavating waste management trenches where several different types of waste streams were likely disposed, no amount of characterization is likely to provide sufficient information about the nature of the waste materials to develop final waste management plans. In this example, a project manager has few options other than to develop contingency plans that would address the different likely types of materials, and to specify how these materials could be handled during waste excavation, segregation, and management of wastes to ensure that appropriate requirements are met.

Decision factors involved in uncertainty management:

1. The impact posed by the uncertainty (Whether or not unexpected circumstances exist and if so, will they negatively impact project implementation?)

2. The effectiveness of available contingency options (Are project uncertainties better managed during implementation if monitoring and contingency plans can easily minimize encountering unexpected conditions on project success? Is it more cost effective to resolve uncertainty during a remedial project than beforehand during characterization?)

3. The feasibility of reducing the uncertainty up-front during characterization, rather than during project implementation through a contingency plan.

2.2 Environmental Management Waste Planning Matrix

See Exhibit 2-1 for the Environmental Management Waste Planning Matrix.

The primary tool for conducting the systematic analysis recommended in this *Guide* is the *Environmental Management Waste Planning Matrix* (see Exhibit 2-1). This matrix allows the project manager to compile critical information about each waste stream that will be generated during an environmental restoration action and evaluate the potential uncertainties that may occur during the activity. Additionally, it assists project managers in making logical choices about characterization needs, if any, for critical decisions related to restoration wastes (i.e., reducing those uncertainties that cannot be managed). Further, the *Environmental Management Waste Planning Matrix* allows a project manager to determine what contingency plans may be required if unexpected conditions are encountered.

The remaining chapters describe the regulatory information needed to complete this planning matrix for wastes generated as a result of remediation of contaminated soil, debris, and ground water. In addition, chapter 3 describes how to address characterization issues related to environmental restoration wastes. The planning matrix described throughout this *Guide* is an iterative tool for use throughout the planning and conduct of environmental restoration projects.

2.2.1 Sources of Information

Information to complete the matrix and conduct the systematic analysis of environmental management waste streams will be found in many places:

- Process-knowledge and analysis from existing data of characteristics of existing waste streams and likely waste residuals following the response action;
- Characterization conducted during the investigation phase of the response action (see Chapter 3); and
- In-process monitoring or characterization conducted during design or implementation.

This *Guide* describes the types of information required to make restoration waste management decisions and strategies for characterization that may be required in any phase of a remediation project.

More information on the use of process knowledge can be found in the *Mixed Waste Testing Guidance* (Office of Environmental Policy and Guidance Memo, December 23, 1997). [http://www.eh.doe.gov/oepa under "Policy & Guidance"]

Characterization information used to complete environmental restoration waste planning matrices is discussed in Chapter 3 of this *Guide.*

2.2.2 Example of Completed Matrix

Exhibit 2-2 presents an annotated version of a completed environmental restoration waste planning matrix for a hypothetical project. For this example, listed hazardous constituents in the soil above action levels have been detected and the likely response action is excavation for disposal offsite at a permitted, commercial disposal facility.

See Exhibit 2-2 for an example of a completed environmental restoration waste planning matrix for a hypothetical project.

Exhibit 2-1: Example Waste Management Planning Matrix

Expected condition of wastestream generated from action	Regulatory and Management Issues	Likely Deviations from expected conditions	Impact to Response Action	Uncertainty Management Approach	Monitoring Plan	Contingency plan
Situation: Evaluation of excavated soil for which only hazardous constituents are expected but radioactive constituents may be present.						
[describe expected condition likely to be found in terms of environmental restoration waste media, contaminant(s)]	[describe anticipated regulatory requirement(s) that will apply based on these expected conditions]	[describe what deviations in terms of media or contaminants present that would trigger different regulatory considerations]	[describe the impact that the likely deviation would have on the anticipated regulatory management strategy]	[describe the planned approach to managing this uncertainty. That is, will the project manager collect more data, monitor the situation and/or develop a contingency plan]	[describe any monitoring plan needed to identify the planned deviation]	[describe any contingency plan needed to manage the situation if the likely deviation was found to exist]

Expected condition of wastestream generated from action	Regulatory and Management Issues	Likely Deviations from expected conditions	Impact to Response Action	Uncertainty Management Approach	Monitoring Plan	Contingency plan
EXAMPLE: Excavated soil is contaminated with only listed hazardous materials.	Land Disposal Restrictions (LDRs)	Excavated soil contains radioactive constituents above background levels.	Planned disposal facility will not accept mixed wastes; disposal costs greatly increase; site must be able to manage mixed waste appropriately.	Process history and current sampling efforts indicate that no radiological contamination is present. Manage remaining uncertainty during action.	Monitor excavated soil for radioactivity above background levels.	Segregate mixed waste immediately; store in appropriate containers; evaluate feasibility (technical and cost) to treat hazardous component of waste prior to disposal; identify a mixed waste disposal facility with capacity if treatment is not feasible.
Excavated soil will not be classified as a RCRA characteristic hazardous waste.	Land Disposal Restrictions	Excavated soil is classified as a RCRA characteristic hazardous waste.	Excavation can continue but the characteristic component of waste must be treated to meet LDRs prior to disposal.	Uncertainty can be managed during action.	As defined in the sampling and analysis plan, obtain a composite sample from each shipment container to determine characteristic wastes are present.	Treat characteristic component of waste with Best Available Demonstrated Technology (BADT).

Exhibit 2-2: Example Completed Waste Management Planning Matrix

Expected condition of wastestream generated from action	Regulatory and Management Issues	Likely Deviations from expected conditions	Impact to Response Action	Uncertainty Management Approach	Monitoring Plan	Contingency plan
Evaluation of excavated soil from waste pits. The remediation plan calls for sludges and soils to be excavated and categorized to facilitate disposal at appropriate waste sites. Based on the waste acceptance criteria (WAC) of the facilities involved, Categories of wastes being evaluated are "typical/non-typical wastes." In addition, evaluation focuses on whether wastes are "processable" at the selected facility. This is a hypothetical scenario only.						
Excavated soil meets the WAC and size requirements for the offsite commercial disposal facility.	Land Disposal Restrictions	Excavated soil is non-typical waste; it does not meet WAC and cannot be treated to meet WAC.	Wastes cannot be shipped offsite to the planned commercial disposal facility for disposal; schedule will be delayed and costs increase; appropriate onsite storage is necessary.	Uncertainty can be managed during action.	As defined in the sampling and analysis plan, obtain a composite sample from each shipment container to determine if WAC are met.	If WAC sampling identifies non-typical waste, place in containers for on-site storage until appropriate disposal facility with capacity is identified.
		Excavated soil is non-processable waste; it meets disposal facility's WAC but doesn't meet size requirements.	Waste cannot be shipped offsite to planned commercial disposal facility for disposal until size is reduced.	Uncertainty can be managed during action.	During excavation, material is evaluated for size.	Segregate oversized material; shred material to meet size requirements of the disposal facility.

Expected condition of wastestream generated from action	Regulatory and Management Issues	Likely Deviations from expected conditions	Impact to Response Action	Uncertainty Management Approach	Monitoring Plan	Contingency plan
Excavated soil is contaminated with only listed hazardous materials.	Land Disposal Restrictions	Excavated soil contains radioactive constituents above background levels.	Planned disposal facility will not accept mixed wastes; disposal costs greatly increase; site must be able manage mixed waste appropriately.	Process history and current sampling efforts indicate that no radiological contamination is present. Manage remaining uncertainty during action.	Monitor excavated soil for radioactivity above background levels.	Segregate mixed waste immediately; store in appropriate containers; evaluate feasibility (technical and cost) to treat hazardous component of waste prior to disposal; identify a mixed waste disposal facility with capacity if treatment is not feasible.
Excavated soil will not be classified as a RCRA characteristic hazardous waste.	Land Disposal Restrictions	Excavated soil is classified as a RCRA characteristic hazardous waste.	Excavation can continue but the characteristic component of waste must be treated to meet LDRs prior to disposal.	Uncertainty can be managed during action.	As defined in the sampling and analysis plan, obtain a composite sample from each shipment container to determine if characteristic wastes are present.	Treat characteristic component of wastes with BDAT.

Expected condition of wastestream generated from action	Regulatory and Management Issues	Likely Deviations from expected conditions	Impact to Response Action	Uncertainty Management Approach	Monitoring Plan	Contingency plan
Volume of excavated soil will not exceed 500 cubic meters.	Capacity of disposal facility	Volume of excavated soil exceeds 500 cubic meters.	Additional shipment containers will be required; excavation can continue but if disposal facility does not have additional capacity, another facility must be identified and storage onsite will be required.	Uncertainty can be managed during action.	Track volume of soil excavated. Once 450 cubic meters has been excavated, implement contingency.	Obtain additional shipment containers than can also be used to store material; identify a different disposal facility if additional capacity cannot be accommodated at planned disposal facility.
Excavated soil will meet RCRA LDRs	Land Disposal Restrictions	Excavated soil does not meet RCRA LDRs	Soil must be treated with the BDAT prior to disposal;	Uncertainty can be managed during action.	As defined in the sampling and analysis plan, obtain a composite sample from each shipment container to ensure that LDRs are met.	Obtain necessary equipment or identify contractors to treat wastes with BDAT.
			Technical difficulties may prevent effective treatment with the BDAT.	Uncertainty can be managed during action.	As defined in the sampling and analysis plan, obtain a composite sample from each shipment container to ensure that LDRs are met.	Segregate waste that cannot be treated; store onsite while obtaining a compliance option (e.g., a treatability variance).

Expected condition of wastestream generated from action	Regulatory and Management Issues	Likely Deviations from expected conditions	Impact to Response Action	Uncertainty Management Approach	Monitoring Plan	Contingency plan
A portion of excavated soil will exceed moisture content allowed for disposal.	Onsite thermal unit capacity and schedule for treatment of wastes and resulting wastestreams.	Excavated soil does not exceed moisture content allowed for disposal.	Negligible impact. No drying is required.	Segregate soil depending on moisture content during action; dispose of soil without treatment if appropriate.	Visual monitoring during excavation will indicate if soil does not exceed allowable moisture content.	
		Greater volumes than expected of excavated soil exceed allowable moisture content.	Excavation can continue but onsite storage will be required if thermal unit cannot dry soil as quickly as it is excavated.	Uncertainty can be managed during action.	Visual monitoring during excavation will indicate if soil exceeds allowable moisture content.	Segregate waste for storage onsite until thermal unit can treat soil.

Expected condition of wastestream generated from action	Regulatory and Management Issues	Likely Deviations from expected conditions	Impact to Response Action	Uncertainty Management Approach	Monitoring Plan	Contingency plan
Evaluation of wastestreams resulting from thermal drying process						
Air emissions resulting from thermal drying unit will be controlled with an off-gas cleaning system and will not exceed air quality control standards.	National Emission Standards for Hazardous Air Pollutants (NESHAPs)	Air emissions resulting from thermal drying unit exceed air quality control standards.	Treatment must halt until air standards are met.	Cannot reduce uncertainty prior to action.	Monitoring stations placed at the point of release from the thermal drying unit (i.e., vent stack) and around the perimeter of the thermal drying unit.	If air quality control standards are not met, stop work, replace filter, load material more slowly into drying unit, increasing volume slowly to ensure compliance with air quality standards.
Large, entrained particulates from cyclone separator, venturi, and HEPA filters must be managed as hazardous waste.	Land disposal restrictions	Materials are not hazardous	Negligible; material can be disposed of onsite as fill.	Sample materials prior to disposal to ensure appropriate management.		
Recycle waster and condensate from spray quench tower scrubber will not require treatment prior to discharge.	NPDES permit	Wastestream does not meet NPDES requirements.	Wastestream requires treatment prior to discharge.	Uncertainty can be managed during action.	As defined in waste management plan, sample wastestream prior to discharge.	If levels of contaminants exceed requirements of NPDES permit, route to wastewater treatment facility prior to discharge.

Exhibit 1-1: Categories of Environmental Restoration Wastes Addressed in this Guide

- ***Hazardous Waste*** is a solid waste that: 1) exhibits a characteristic of a hazardous waste; 2) is a listed hazardous waste; 3) is a mixture of a hazardous waste and a nonhazardous waste; or 4) is derived from the treatment storage, or disposal of a listed waste. States may expand on or make more stringent definitions under their delegated authority. 40 CFR 260 and 261 define hazardous wastes at the Federal level.
- **Transuranic Waste (TRU)** is radioactive waste that contains more than 100 nanocuries (3700 becquerels) of alpha-emitting transuranic isotopes per gram of waste, with half-lives greater than 20 years, except for: 1) High level radioactive waste; 2) Waste that the Secretary of Energy has determined, with the concurrence of the Administrator of the EPA, does not need the degree of isolation required by the 40 CFR Part 191 disposal regulations; or 3) Waste that the Nuclear Regulatory Commission (NRC) has approved for disposal on a case-by-case basis in accordance with 10 CFR Part 61. [Source: *WIPP (Waste Isolation Pilot Plant) Land Withdrawal Act of 1992*, as amended]
- ***Low-Level Waste (LLW)*** is radioactive waste that is not HLW, spent nuclear fuel (SNF), TRU, by-product material (as defined in section 11(e.)(2) of the *Atomic Energy Act of 1954*, as amended (AEA)), or naturally occurring radioactive material. [Adapted from: *Nuclear Waste Policy Act of 1982*, as amended]
- ***Mixed Waste*** is waste that contains both radioactive (source, special nuclear, or by-product material) and hazardous components subject to the AEA as amended and the RCRA, respectively. [Adapted from: *Federal Facility Compliance Act of 1992]* Mixed waste is further defined as high level mixed, transuranic mixed, or low-level mixed wastes. Unless demonstrated otherwise, all high-level waste shall be considered mixed waste and is subject to the requirements of the AEA and the RCRA, according to DOE M 435.1-1, Chapter II (C)(1).
- ***Other Wastes*** (not an official waste type) may also be found as part of environmental remediation activities at DOE sites. For example, polychlorinated biphenyls (PCBs) and asbestos may be found at DOE sites. These wastes are regulated under the Federal Toxic Substances Control Act (TSCA), and in some States, they are considered to be hazardous wastes under State law. They may or may not be found in mixtures containing Federal hazardous wastes or radioactive wastes.

Hazardous wastes are either characteristic or listed wastes (or sometimes both) Characteristic wastes exhibit one of the following traits: ignitability, corrosivity, reactivity, or toxicity [40 CFR 261.21-24]. Listed hazardous wastes are source specific, non-specific source, or commercial chemical products waste (see 40 CFR 261.31-33).

A curie is a unit measuring radioactive decay. Specifically, one curie is 37 billion atoms undergoing decay each second. A "nanocurie" is one billionth of a curie.

Although DOE sites also manage spent nuclear fuel and high-level waste, these are generally not found as part of remediation projects and are not discussed further in this *Guide*. DOE Order 435.1 defines spent nuclear fuel as

> *fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated by reprocessing. Test specimens of fissionable material irradiated for research and development only, and not production of power or plutonium, may be classified as waste, and managed in accordance with the requirements of DOE O 435.1 when it is technically infeasible, cost prohibitive, or would increase worker exposure to separate the remaining test specimens from other contaminated material*.

The Order defines high-level waste is defined as

> *the highly radioactive waste material resulting from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid material derived from such liquid waste that contains fission products in sufficient concentrations; and other highly radioactive material that is determined, consistent with existing law, to require permanent isolation.*

1.3 Regulatory Basis for Environmental Restoration Waste Management

Compliance with all environmental laws that apply to remediation activities is required under both CERCLA and RCRA corrective action projects. The legal mechanism, however, is different for each program.

Guidance on ARARs compliance can be found in *CERCLA Compliance with Other Laws Manual, CERCLA Compliance with State Requirements,* (OSWER Dir. 9234.2-05/FS, EPA 1989) and *CERCLA Compliance with Other Laws Manual: Guide to Manual,* (OSWER Dir. 9234.2-02/FS, EPA 1989). These are not available on the Internet, but can be obtained from the EPA RCRA/CERCLA Hotline by calling: (800) 424-9346.

For CERCLA actions, subsection 121(d) of CERCLA specifies that on-site Superfund remedial actions must attain federal standards, requirements, criteria, limitations, or more stringent state standards determined to be legally applicable or relevant and appropriate (ARAR) to the circumstances at a given site. To be applicable, a state or federal requirement must directly address the hazardous substance, the action being taken, or other circumstance at the site. A requirement that is not applicable may be relevant and appropriate if it addresses problems or pertains to circumstances similar to those encountered at a Superfund (CERCLA) site. ARARs are used in conjunction with risk-based goals to govern Superfund response activities and to establish cleanup goals.

For wastes that are hazardous for example, a variety of substantive requirements may be treated as ARARs if CERCLA site-specific activities are considered treatment, storage, and disposal activities regulated under Subtitle C. RCRA Subtitle C regulations (appearing in 40 CFR Parts 260-299), which govern hazardous waste from the point of generation through the point of disposal, commonly are applicable or relevant and appropriate to CERCLA response actions. These requirements are outlined in detail in Chapters 4 through 6 of this Guide as they apply to ground water, soil, and debris, respectively, that are themselves hazardous wastes or contain hazardous wastes that are listed or exhibit one of the four characteristics (toxicity, corrosivity, ignitability, or reactivity) outlined in 40 CFR 261.21-24.

EPA's current interpretation of the CERCLA Section 121(e) permit exclusion establishes that RCRA administrative standards (in addition to substantive requirements) apply when hazardous wastes are sent off-site for further management. Administrative RCRA standards include the obligation to obtain permits and keep various records at all hazardous waste treatment, storage, and disposal facilities (TSDFs); and the requirement to include a hazardous waste manifest when sending hazardous wastes offsite.

CERCLA's off-site rule (40 CFR 300) requires that only facilities that meet EPA's acceptability criteria can be used for off-site management of CERCLA waste, including transfer facilities. More information can be found in the CERCLA Information Brief *The Off-Site Rule*, EH-231-020/0194, March, 1994, available for downloading at [http://www.eh.doe.gov/oepa under "Policy & Guidance"].

In addition, CERCLA has established additional requirements that project managers must meet when wastes are sent off site to a management facility (known as the off-site rule).

Under the current RCRA national corrective action program, corrective action requirements or regulations applicable to restoration wastes are limited to 40 CFR 264.100 [*Corrective Action Program*], 40 CFR 264 Part 264.101 [*Corrective Action for Solid Waste Management Units*], 40 CFR 264.552 and 553 [*Corrective Action Management Units (CAMU)* and *Temporary Units (TU)*, respectively]. Although there are limited corrective action regulatory requirements, the EPA has, over the years, issued a number of guidance documents which are used to direct the program. Currently, the primary guidance document for the corrective action program is the *Corrective Action for Releases from Solid Waste Management Units at Hazardous Waste Management Facilities: Advanced Notice of Proposed Rulemaking (ANPRM)*, 61 FR 19432, May 1, 1996. Prior to the issuance of the ANPRM, the primary guidance document was the *Corrective Action for Releases from Solid Waste Management Units at Hazardous Waste Management Facilities ("Subpart S"): Proposed Rule*, 55 FR 30798, July 27, 1990. The "Subpart S" proposed Rule was partially withdrawn by the EPA in 1999 [64 FR 54604, October 7, 1999].

EPA's RCRA corrective action program has made these policy decisions in the context of its remedy selection process. EPA guidance on remedy selection is part of EPA's current RCRA corrective action national training initiative and EPA has issued *Final Remedy Selection for Results-Based Corrective Action (December 13, 1999)* that addresses this concept.

Given the recent withdrawal of the 1990 proposed Subpart S [64 FR 54604, October 7, 1999, http://www.epa.gov/epaoswer/hazwaste/ca/partwith.htm] comprehensive national regulation for RCRA corrective actions, there is limited specific direction from EPA on when the requirements of other laws must be met during corrective action projects. However, in its recent policy training (*RCRA Corrective Action Workshop on Results-Based Project Management*, 1999) EPA has stated that any requirements of RCRA or other laws that are legally applicable are inherent elements of remedy selection evaluations under the RCRA corrective action program.

Chapter 3: Characterization of Environmental Restoration Wastes

3.1 Drivers of Characterization For Environmental Restoration Wastes

Environmental restoration investigations (i.e., remedial investigations, RCRA facility investigations) seldom, if ever, result in a project manager learning all of the information needed to manage environmental restoration wastes. Effective sampling and analysis data gathered during these investigations, historical information regarding site operations, and information regarding the characteristics of contaminated ground water, soil, and debris, will assist the remedial project manager in identifying the range of potential regulatory requirements that could apply to each type of environmental restoration waste. Furthermore, this information should allow a project manager to better identify expected circumstances for each environmental restoration waste stream. Once these expected circumstances are defined, project managers can then determine which, if any, remaining uncertainties need to be managed to avoid unintended, negative consequences when a project is actually implemented.

The primary roles of site characterization include:

1. To determine applicable regulatory requirements and manage unexpected circumstances.

2. To determine how to meet appropriate waste management regulations or site-specific permit or operating requirements.

Characterization activities have two primary objectives relative to planning for environmental restoration waste management. First, characterization may provide the information that a program manager needs to determine what the likely regulatory requirements may be, and what, if any, other regulations might apply if actual circumstances differ from those expected to exist. Second, characterization activities may also be needed to substantiate that environmental restoration waste management practices satisfy appropriate waste management regulations or site-specific permit or operation requirements (e.g., WAC, compliance with a National Pollution Discharge Elimination System (NPDES) permit).

For example, DOE facilities such as WIPP, and the Nevada Test Site radioactive waste management complex both have WAC, and corresponding certification programs, to ensure that only compliant waste streams are sent to their facilities. According to DOE M 435.1-1, facilities for TRU waste must at a minimum have WAC that:

- Specify allowable waste management activities and/or concentrations of specific radionuclides;
- Specify acceptable waste form and/or container requirements that ensure the chemical and physical stability of waste under conditions that might be encountered during transportation, storage treatment or disposal;
- Specify restrictions or prohibitions on waste, materials, or

Additional guidance on regulatory interpretations and waste characterization issues is also available on the EH-41 website at: [http://www.doe.gov/oepa] or from EPA's *Waste Analysis of Facilities that Generate, Treat, or Dispose of Hazardous Waste - A Guidance Manual*, U.S. EPA, EPA-530-R-94-024, April 1994.

containers that may adversely affect waste handlers or compromise facility or waste container performance;

- Identify TRU as defense or non-defense, and specify limitations on waste acceptance; and

- Specify the basis, procedures, and levels of authority required for granting exceptions to the waste acceptance requirements, which shall be contained in each facility's waste acceptance documentation. Each exception request shall be documented, including its disposition as approved or not approved.

Facilities accepting low-level waste must establish WAC that at a minimum:

DOE M 435.1-1 establishes minimum WAC that facilities must establish for TRU wastes (Chapter III.G), and low-level wastes (Chapter IV.G). [http://www.explorer.doe.gov:1776/htmls/currentdir.html].

- Specify allowable waste management activities and/or concentrations of specific radionuclides;

- Specify acceptable waste form and/or container requirements that ensure the chemical and physical stability of waste under conditions that might be encountered during transportation, storage treatment or disposal; and

- Specify restrictions or prohibitions on waste, materials, or containers that may adversely affect waste handlers or compromise facility or waste container performance.

It is important to remember that because a waste management site will refuse to accept environmental restoration wastes that do not meet its WAC, project managers should routinely check the WAC of a planned waste management facility beginning early in the restoration project to ensure that they have accurate information and that waste meets a facility's disposal or management requirements.

This chapter summarizes the major technical and regulatory issues that must be considered when characterizing environmental restoration wastes. It also discusses the key questions that a program manager must be able to answer to plan and implement an effective waste management approach.

3.2 Specific Questions Project Managers May Require Characterization to Answer

For project managers to manage environmental restoration wastes systematically, they must be able to answer a number of key questions. Some of these questions may be answered sufficiently using historical records, process knowledge, and/or existing sampling information. If any of the key questions cannot be answered using existing information, additional sampling and analysis activities (as part of a planned investigation) may be needed, existing information reevaluated, or contingency approaches developed to determine the answers. The specific questions project managers may require characterization to answer include:

- *What are the expected characteristics of the waste(s) (e.g., contaminant type, constituents, physical characteristics) that will be generated during remediation? Given these expected conditions, what regulatory requirements are applicable or, for CERCLA actions, are also relevant and appropriate to consider)?* Specifically, a project manager must consider whether environmental restoration wastes will be hazardous, radioactive, or mixed wastes and have sufficient data to determine what parts of corresponding regulations apply (e.g., do concentrations levels of hazardous wastes present already meet LDR (land disposal restriction) treatment standards or is treatment of any wastes generated during the action required?). Project managers must also determine if the wastes will be co-regulated under other Federal statutes or State programs (e.g., are PCBs regulated as hazardous wastes in a certain State). By defining which regulatory framework(s) will likely govern management of environmental restoration wastes, a project manager can identify compliant options for the management and final disposition of wastes or determine when regulatory variances may be needed.

Characterization decisions must address the expected characteristics of the waste stream, in addition to considering ARARs for CERCLA actions and applicable requirements for RCRA corrective actions.

- *What are the potential impacts of these applicable (or relevant and appropriate) regulations on planned waste handling and waste management?* After project managers define which regulatory framework(s) will likely apply to the management of environmental restoration wastes, they can evaluate the potential impacts of regulations and determine how these requirements can be integrated into plans designed to meet the statutory and regulatory requirements (e.g., protect human health and the environment). For example, management of hazardous wastes may require treatment prior to disposal to meet LDR treatment standards, and characterization may be required to determine whether various proposed treatment approaches can achieve promulgated LDR treatment levels. In other cases, project managers may require specific types of data to justify a variance or alternate approach that must be approved by regulators before implementation of a response can be initiated.

The impacts of any applicable regulatory requirements or of ARARs on planned waste handling and waste management should also be considered during the waste characterization process.

- *What uncertainties exist? Specifically, are deviations from expected circumstances likely? How likely are they? What would the impact be of encountering these unexpected circumstances?* The impact of encountering unexpected conditions ranges from significant to negligible. A significant

Waste characterization processes should take into account the presence of existing uncertainties, the likelihood of future uncertainties in an environmental restoration project, the potential impact such uncertainties may have on the project and any deviations from expected circumstances.

impact is one that would cause a change in waste handling and management were an unexpected condition to occur. For example, if soil being managed as hazardous waste is found to contain any radioactive contaminants (an unexpected circumstance) in addition to hazardous waste constituents (an expected circumstance), the material must be handled as a mixed radioactive waste. Additionally, the project manager must determine if disposal at a mixed waste facility is appropriate, or if treatment prior to disposal (rending the waste no longer hazardous) could allow the waste to be managed only as a low-level radioactive waste.

A negligible or insignificant impact is one that would not impact how an environmental restoration waste stream is managed. For example, concentrations of radioactive constituents in soil may be greater than expected, but still result in a waste being classified as a LLW. In this case, if the project manager knows in advance that the receiving facility can still accept the waste because the higher concentrations still meet all WAC, no further evaluation of this unexpected circumstance is likely necessary.

- *What is the likely final disposition of environmental restoration wastes?* The quality and quantity of data required to ensure that waste is managed appropriately also depend on the likely final disposition of environmental restoration wastes (e.g., disposal onsite, disposal offsite, recycling of material). The likely final disposition may also impact when data need to be collected.

  For example, an off-site disposal facility's WAC may specify not only the number of composite samples to be analyzed, but when they must be collected and analyzed (e.g., before wastes are shipped, to verify they meet WAC, and a certain number after wastes have been packaged for transportation to ensure that the wastes shipped are consistent with the initial verification sample). For wastes dispositioned in place, on the other hand, limited (if any) sampling may be required before capping, but extensive sampling from monitoring wells during post-closure periods will likely need to be implemented.

The likely final disposition of an environmental restoration waste stream is a vital consideration of waste characterization processes.

Evaluation of these types of questions should be a routine part of environmental restoration projects, from initial scoping (where a project team first identifies the problems requiring remediation, likely response actions, and characterization needs to select a response) through remedial design and implementation, when environmental restoration wastes are actually managed and potential uncertainties may become management realities.

3.3 Timing and Data Quality Issues

The specific techniques for sampling and analyzing environmental restoration wastes and issues associated with obtaining data that are of appropriate quality to make decisions (e.g., ways of obtaining samples, sample management, test methods, use of field instruments vs. traditional laboratory analysis) are generally the same as they are for other characterization activities. There are, however, certain timing and quality considerations that may be specific to restoration waste management.

More information on process knowledge can be found in *Mixed Waste Testing Guidance* (Office of Environmental Policy and Assistance Memo, December 23, 1997), and *Management of Remediation Waste under RCRA* (EPA 530-F-98-026), October 1998. [http://www.eh.doe.gov/oepa under "Policy &Guidance"]

3.3.1 When Characterization for Environmental Restoration Wastes is Needed

Many of the data that are traditionally available or are collected during the investigations that precede remedy implementation can also be used to anticipate which environmental restoration wastes will be present at a site and how they should be managed. For example, a general understanding of likely contaminant types often can be obtained from historical process knowledge of site operations and data collected to determine the location and magnitude of risks posted by past site releases. Once available, this information allows a project manager to begin to determine the regulatory framework under which the project likely will be conducted and the implications these regulations likely will have on environmental restoration waste management activities.

In some cases, traditional data that are collected may need to be supplemented with data that specifically answer key questions about environmental restoration waste management issues. For example, although total concentrations of an inorganic contaminant often will be needed to establish whether a release poses a risk to human health or the environment, determining whether the waste is hazardous (and, therefore, whether it will trigger RCRA Subtitle C requirements if it is excavated, stored, treated, or re-disposed) may require that a project manager conduct a toxicity characteristic leaching procedure (TCLP) analysis.

Therefore, a project manager should identify key uncertainties about potential environmental restoration waste streams as early in projects as possible to determine what, if any, additional analysis is needed to evaluate potential alternatives that are being considered for the waste.

3.3.2 Degree of Data Quality Required for Waste Management

The data quality needed for making environmental restoration waste management decisions is based on two factors: 1) the data quality requirements established by specific regulations, permits, or WACs; and, 2) the amount of certainty that the project team requires to make waste management decisions.

The quality of data needed to meet regulatory requirements, in most cases, are clearly defined in the regulations themselves or in site-specific documents such as permits or operating plans. Project managers should consult these to determine what methods, for example, are acceptable to make these types of restoration waste management decisions.

The amount of certainty a project team requires to make decisions is much more variable and is a key element of successfully completing the Environmental Waste Management Planning Matrix in Chapter 2. In some cases, by carefully defining and evaluating uncertainties, the project team may discover that it is able to plan an acceptable waste management approach for environmental restoration wastes using only data available already.

For instance, a project team may decide that process history information and existing sampling data (e.g., collected to ensure worker health and safety during remediation) are satisfactory to determine that the expected circumstance that debris resulting from demolition of a radioactively contaminated facility is low-level radioactive waste, and that encountering TRU waste is unlikely. Because the project team can also rely on field monitoring information during implementation to ensure that no unexpected TRU waste is encountered, the team could decide that no additional characterization would be required prior to action. The project team could then conduct the demolition in a manner to control the release of radioactive contamination (e.g., through continuous spraying of the facility to control dust), and manage the resulting debris as LLW. In this case, additional characterization for waste management purposes might only be required to substantiate that the debris meets storage and transportation requirements, and the WAC of the disposal facility prior to shipping it offsite or disposing of it onsite.

If the project team determines that data quality is of concern for making waste management decisions, EPA's Data Quality Objective (DQO) approach is a tool that allows a project team to ensure that environmental restoration waste is characterized in an effective, resource-efficient manner. The DQO Approach provides a systematic procedure for defining waste characterization design criteria, including when, where, and how many samples to collect, and the acceptable level of data uncertainty. Because it is not always necessary to know the concentrations or extent of contamination to make waste management decisions, the level of data required to make decisions is in many cases much less than that required for a risk assessment.

For more information, see *Using the Data Quality Objectives Process in Risk Assessment*, EH-231-023/0794, July, 1994, available for downloading at [http://www.eh.doe.gov/oepa/ under "Policy and Guidance"] and DOE Order 435.1-1, *Radioactive Waste Management Manual*, July, 1999 [http://www.explorer.doe.gov:1776/htmls/currentdir.html].

3.4 Requirements For Characterizing Various Waste Types

This section describes major considerations for characterizing different waste types (e.g., hazardous, radioactive, mixed, other) including variances for which characterization data may be needed.

3.4.1 Hazardous Waste

Characterization of hazardous environmental restoration wastes often involves determining if the restoration waste meets the definition of a hazardous waste as defined in 40 CFR 261.3 or corresponding state environmental regulations. Environmental media contaminated with a listed or characteristic hazardous waste is considered hazardous under the "contained in" policy. As long as the environmental media "contains" the hazardous waste or exhibits a hazardous waste "characteristic", it needs to be managed as a hazardous waste.

Characteristic Wastes

Contaminated media or waste will have to be managed as a hazardous waste as long as it exhibits a hazardous waste characteristic [40 CFR 261.3]. The trigger levels for each type of hazardous waste characteristic are listed in Exhibit 3-1.

Listed Wastes

A major policy to determine if contaminated environmental media is subject to hazardous waste requirements is the "contained-in" policy. This policy requires that media containing listed wastes must be managed as listed wastes until they no longer contain the waste (sometimes referred to as the "contained-out" policy).

To determine if contaminated media must be managed as a hazardous waste because it contains a listed waste, the site manager will need to review process history information to determine how the original waste was generated. A listed waste is any waste that appears on one of three EPA lists of hazardous wastes: non-specific source wastes, specific source wastes, or discarded commercial materials found in 40 CFR 261 Subpart D. Types of listed hazardous waste are found in Exhibit 3-2.

If the facility owner/operator cannot determine if the waste is a listed hazardous waste, according to the memo, *Management of Remediation Waste Under RCRA*, (EPA 530-F-98-026, October 1998), states:

> *Where a facility owner/operator makes a good faith effort to determine if a material is a listed hazardous waste but cannot make such a determination because documentation regarding a source of contamination, contaminant, or waste is unavailable or inconclusive, EPA has stated that one may assume the source, contaminant or waste is not listed hazardous waste and, therefore, provided the material in question does not exhibit a characteristic of hazardous waste, RCRA requirements do not apply*.

Exhibit 3-1
Properties of a Characteristic Hazardous Waste

Property	Trigger Levels	Test Method	Reference
Ignitable	Liquids with less tan 24 % alcohol and a flash point < 140 °F Solids capable of causing fire through friction, absorption of moisture, or spontaneous chemical changes that when ignited will burn vigorously enough to create a hazard.	Closed Cup Tester specified in ASTM standard D-93-80 or in ASTM standard D-3278-78.	40 CFR 261.21
Corrosive	Liquids with a pH ≤2 or pH ≥12.5 Liquids that corrode steel (SAE 1020) at a rate of 6.35 mm/yr at 130 °F	EPA test method set forth in 260.20. NACE standard TM-01-69	40 CFR 261.22
Reactive	Normally unstable and readily undergoes violent changewithout detonating. Reacts violently or forms potentially explosive mixtures with water . Generates toxic gases, vapors, or fumes when mixed with water. It's a cyanide or sulfide bearing waste capable of generating toxic fumes. It is capable of detonation or explosive reaction if subjected to an initiating source or if heated under confinement. It is a forbidden, Class A, or Class B explosive as defined in 49 CFR 173.51, 173.53, or 173.88, respectively.	Not specified.	40 CFR 261.23
Toxic	Wastes that leach the constituents listed in 40 CFR 261.24 at or above specified concentrations.	TCLP.	40 CFR 261.24

Exhibit 3-1 outlines the properties of characteristic hazardous waste, including chemical properties, regulatory trigger levels, testing methods and applicable statutory references.

EPA routinely issues directives, letters, and other policy interpretations that clarify when wastes are hazardous. Examples include: *RCRA Regulatory Status of Contaminated Groundwater*, and *RCRA Regulation of Wastes Handled by DOE Facilities*.

Exhibit 3-2
Listed Hazardous Waste Types

Exhibit 3-2 describes listed hazardous waste types by source of generation, description reference code, applicable regulation and frequency of occurrence at DOE sites.

Source	Description	Code	Cite	Occurrence at DOE Sites
Non-specific Sources	Generic wastes produced from a variety of manufacturing and industrial processes. To determine if F listing applies, information is needed on the specific process that generated the waste as well as the constituents present.	F	40 CFR 261.31	Spent solvents (F001-F005) are common at DOE sites
Specific Sources	Wastes originating from specific industries. These wastes are less likely to be present at DOE sites.	K	40 CFR 261.32	Not common because DOE production processes are generally not listed
Discarded commercial materials	Commercial chemical products, off-specification products, or the residue, container, or contaminated media of a commercial chemical product that has been discarded or intended to be discarded.	P or U	40 CFR 261.33	Not common but may be found if products were discarded without use

3.4.2 When Is a Waste No Longer Hazardous Waste?

Media contaminated with a hazardous waste, must be managed as hazardous waste until it is either delisted, no longer "contains" listed wastes, and/or no longer exhibits a characteristic of a waste [40 CFR 260.22].

Environmental restoration waste contaminated with listed wastes will no longer be considered a hazardous waste if the contaminating waste is "delisted". Delisting is a formal agency rulemaking procedure where the EPA Regional Administrator grants exemption to a waste listing on a facility- and waste-specific case-by-case basis. It is important to note that a site may determine that it is more cost effective to manage and dispose of a hazardous waste as such without attempting to delist it (because delisting can be time-consuming and expensive).

Under EPA's "contained in" policy, environmental media contaminated with a RCRA listed hazardous waste must be managed as hazardous waste until the media no longer "contains" the hazardous waste. A media is considered to no longer "contain" hazardous waste (1) when they no longer exhibit a characteristic of hazardous waste; and (2) when concentrations of hazardous constituents from listed hazardous wastes are below health-based levels. In a rule published on August 18, 1992 (57 FR 37193-37264), EPA codified the "contained in" policy specifically for debris. Although the "contained in" policy has not been codified for other media, EPA has interpreted the policy to apply to all contaminated media that contain a hazardous waste.

In addition to the contained-in policy, EPA has established a low-level threat variance (see 40 CFR 268.44(h)(4), promulgated May 26, 1998) for contaminated soils (see Chapter 5 for more details).

Additional information on delisting can be found in the EPA's Fact Sheet *Delisting Petitions and the Petition Review Process*, EPA-530-F-93-005, April 1993.

The determination that soil, ground water, or debris no longer contains a listed waste is made by the EPA Regional Administrator (or authorized state) on a case-by-case basis. Once the medium has been determined to be "clean" by the regulator, the medium can be returned to the ground (e.g., reinjected, applied to the land) without triggering the RCRA Subtitle C restrictions.

Media contaminated with a characteristic waste is no longer hazardous once it does not display the characteristic that caused the waste to be defined as hazardous. Therefore, if the medium no longer meets the trigger levels that define ignitability, corrosivity, reactivity, or toxicity, then the medium is no longer hazardous and can be disposed of, or reapplied to the land without triggering further RCRA Subtitle C restrictions.

One potential exception to this circumstance is that once a characteristic hazardous waste becomes subject to RCRA land disposal restrictions, the waste may still require treatment to the LDR treatment standard even though the waste itself no longer exhibits a hazardous waste characteristic. When a waste is hazardous by the characteristic of toxicity, once the LDR treatment standards are triggered, treatment must occur to meet the universal treatment standards for all underlying hazardous constituents reasonably expected to be present (or alternate standards for contaminated soil), which, in some cases, are more stringent than the level at which the waste is defined to exhibit a characteristic.

Chapter IV of DOE Order 5400.5 outlines the requirements and guidelines for the release of property, applicable at the time that the property is released. The Order establishes that authorized limits must be met for remedial actions to be considered complete and for property to be released without restrictions on use due to residual radioactive material. The OEPA has developed guidance on property release under 5400.1. These are "Application of DOE 5400.4 – Requirements for Release and Control of Property Containing Residual Radioactive Material", and "Handbook for Controlling Release for Reuse or Recycle of Non-Real Property Containing Residual Radioactive Material" [http://www.eh.doe.gov/oepa under "Policy and Guidance"].

3.4.3 Radioactive Waste[1]

Under DOE M 435.1-1, radioactive waste is defined as any garbage, refuse, sludges, and other discarded material, including solid, liquid, semisolid, or contained gaseous material that must be managed for its radioactive content.

In general, a project manager needs to conduct characterization of media with radioactive constituents to determine:

1) if the material requires remediation because the radionuclides pose an unacceptable risk to human health and the environment or exceed regulatory guidelines,

2) the classification of waste (e.g., LLW, TRU, mixed), and

3) if the contaminated media can be released without restriction due to radioactive content (see note below).

The minimum waste characterization requirements for TRU waste and LLW are set forth in DOE M 435.1-1. For TRU, the minimum waste characterization requirements, contained in Chapter III.I(2) of DOE M 435.1-1, include:

- Physical and chemical characteristics of the waste;
- Waste volume, including the waste and any stabilization or absorbent media;
- The weight of the waste container and its contents;
- Identities, activities, and concentrations of major radionuclides;
- Characterization date;
- Generating source;
- Packaging date; and
- Any other information which may be needed to prepare and maintain the disposal facility performance assessment or demonstrate compliance with applicable performance objectives.

The following minimum waste characterization requirements, contained in Chapter IV.I(2) of DOE M 435.1-1 apply to LLW:

Characterization of environmental media containing radioactive materials must be conducted in order to determine:

1. If the material poses unacceptable human health or environmental risks, or if such material exceeds regulatory limits and must be remediated.

2. The classification of the waste (e.g., HLW, TRU, LLW)

3. If the material can be released without restriction due to its radioactive content.

[1] NOTE: On January 12, 2000, the Secretary of Energy placed a moratorium on the Department's release of volumetrically contaminated metals pending a decision by the Nuclear Regulatory Commission (NRC) whether to establish national standards [News Release – Energy Secretary Richardson Blocks Nickel Recycling at Oak Ridge]. Therefore, the Department will not allow the release of scrap metals for recycling if contamination from DOE operations is detected using appropriate, commercially available monitoring equipment and approved procedures. Consequently, the unrestricted release for recycling of scrap metals from radiation areas is suspended until improvements in release criteria and information management have been developed and implemented. Additionally, on July 13, 2000, the Secretary [Secretarial Memorandum-Release of Surplus and Scrap Materials] directed further action in four areas: (1) improvement of the Department's release criteria and monitoring practices; (2) expansion of efforts to promote reuse and recycling within the complex of DOE facilities; (3) improvement of the Department's management of information about material inventories and releases; and, (4) the accelerated recovery of sealed sources as described in the July 13, 2000, Secretarial memorandum. While updated release criteria and record keeping procedures are being developed and implemented, the Department will undertake several activities to promote internal reuse and recycling. Finally, when revised directives and guidance are in place, the Department will require each DOE site to have local public participation before the site may resume the unrestricted release for recycling of scrap metals from radiation areas.

- Physical and chemical characteristics of the waste;
- Waste volume, including the waste and any stabilization or absorbent media;
- The weight of the waste container and its contents;
- Identities, activities, and concentrations of major radionuclides;
- Characterization date;
- Generating source; and
- Any other information which may be needed to prepare and maintain the disposal facility performance assessment or demonstrate compliance with applicable performance objectives.

Typically, each of these minimum requirements are specified in more detail through a receiving facility's WAC.

Conditions under which material with radioactivity may be released depends in part on the media of concern. Media that is non-porous and not "bulk" material (e.g., steel debris resulting from facility demolition) may be released without restrictions due to radioactivity using surface contamination criteria established in DOE Order 5400.5 or NRC's Regulatory Guide 1.86. Consequently, for non-porous materials, characterization is typically focused on ensuring that the average, maximum, and removable surface contamination meets release criteria. A characterization survey of this type generally consists of surface smears and measurements of the disintegrations per minute (dpm), taken with a hand-held meter.

For porous material (e.g., concrete debris) or bulk material (e.g., soil, ground water), characterization for radioactivity is measured in two ways: dose and curie content counts. The type of characterization required to establish that a remedial action is complete is based on whether or not generic guideline values exist. Generic guidelines are cleanup values that have been established independently of the site and are taken from existing radiation protection standards. For example, DOE 5400.5 establishes the following guideline value for Ra-226: 5 pCi/g of Ra-226, averaged over the first 15 cm of soil below the surface and 15 pCi/g of Ra-226, averaged over 15-cm-thick layers of soil more than 15 cm below the surface. Characterization to demonstrate that a media meets generic guideline values is generally measured using curie content counts.

If generic guidelines do not exist, specific property guidelines must be derived from a basic dose limit, using specific property models and data. The basic dose limit, as established in DOE Order 5400.5, is 100 mrem per year above background to members of the public, taking into account all exposure modes and all DOE sources of radiation. However, for practical purposes, DOE has interpreting this dose limit to be constricted to 30 mrem/yr.

DOE has provided additional guidance regarding radiological release requirements in *Response to Questions and Clarification of Requirements and Processes: DOE 5400.5, Section II.5 and Chapter IV Implementation (Requirements Relating to Residual Radioactive Material);* dated 11/17/95 [http://www.eh.doe.gov/oepa/ under "Policy and Guidancc"].

To determine specific property guidelines for radioactive wastes, a site must additionally consider all significant exposure pathways for reasonably expected uses, including exposures to workers conducting corrective actions at disposal facilities. Specific property guidelines governing LLW facilities must also take into account unforseen temporary human intrusion into the waste disposal facility following closure. Under DOE 435.1 IV (P)(2)(h), dose limits of 100 millirems/year and 500 millirems total effective dose equivalent, excluding airborne radon are set for chronic and acute exposure scenarios involving inadvertent human intruders.

"Remediation waste" means media containing PCBs as a result of a spill, release, or other unauthorized disposal.

3.4.4 Characterization of Other Wastes (PCB and Asbestos)

A determination that a waste does not meet the definition of either hazardous, radioactive, or mixed waste, does not mean that the waste is exempt from any regulatory requirements. Non-hazardous and non-radioactively contaminated wastes may still be subject to Federal solid waste restrictions, State requirements, or on-site and off-site waste acceptance criteria. If environmental restoration wastes are generated that are not characterized as either hazardous, radioactive, or mixed waste, the project manager should consult State and local regulatory agencies to investigate the potential for regulatory restrictions on the management of that waste.

In characterizing environmental restoration wastes containing PCBs and asbestos bearing materials, two elements must be considered:

1. **The concentration of PCBs.**
2. **Whether or not the asbestos bearing material is friable or non-friable**, **and which category the material is classified in, as shown in Exhibit 3-3.**

Two special categories of materials often encountered as part of remediation actions are PCBs and asbestos-containing materials. A critical piece of characterization information for PCBs is the concentration of PCBs. In particular, it is important to determine (1) whether PCBs are greater than 50 ppm or greater than 500 ppm because different disposal regulations apply depending on these concentration thresholds, and (2) whether the PCB material is "remediation waste" as defined in 40 CFR 761.61 or another type of regulated PCB article.

For more information, see *PCB Spill Response and Notification Requirements*, EH-231-059/1294, and *Regulatory Requirements Affecting Disposal of Asbestos-Containing Waste*, EH-413-062/1195, **available from the OEPA web site (see below).**

The TSCA regulations do allow certain assumptions to be made about the PCB concentration of spilled material if the actual concentration is unknown. For example, fluids of unknown PCB concentration released as the result of a transformer rupture must be assumed to have a PCB concentration of greater than or equal to 500 ppm if the transformer's nameplate indicates that the transformer contains PCB dielectric fluid or if dielectric fluid with a PCB concentration greater than or equal to 500 ppm is known or suspected to have been added to the transformer.

For asbestos, critical characterization information is whether the waste is friable or non-friable, and which category the material is classified in, as shown in Exhibit 3-3.

Exhibit 3-3
Categories of Asbestos-Containing Material

Category	Definition
Category I non-friable asbestos-containing material	Asbestos-containing packings, gaskets, resilient floor covering, and asphalt roofing products containing more than 1 percent asbestos
Category II non-friable asbestos-containing material	Any material, except Category I non-friable asbestos-containing materials, containing more than 2 percent asbestos that, when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure.
Regulated asbestos-containing material	Friable asbestos material; Category I non-friable asbestos containing material that has become friable; Category I non-friable asbestos-containing material that will be subject to sanding, grinding, cutting or abrading; and Category II non-friable asbestos-containing material that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder by the forces expected to act on the material in the course of demolition or renovation operations.
Asbestos-containing waste materials	Regulated asbestos-containing materials waste and materials contaminated with asbestos during demolition and renovation operations, including disposable equipment and clothing.

Friable asbestos material is defined as any material containing more than 1 percent asbestos that, when dry, can be crumbled, pulverized, or reduced to powder by hand pressure. Non-friable asbestos is any material that does not meet this definition.

See *Regulatory Requirements Affecting Disposal of Asbestos-Containing Waste*, EH-413-062/1195 (November, 1995) on the EH-41 web site, [http://www.eh.doe.gov/oepa/ under "Policy & Guidance].

Chapter 4
Management of Contaminated Ground Water During Environmental Restoration Projects

Management requirements for three types of media are presented in the following three chapters:

Chapter 4 Ground Water
Chapter 5 Soils
Chapter 6 Debris

This chapter addresses how to manage ground water when it is an environmental restoration waste. The requirements for handling, managing, and disposing of ground water as an environmental restoration waste are provided in separate sections for hazardous wastes, radioactive wastes, and mixed wastes. The following exhibit outlines each section of this chapter and its contents:

For more information on ground water remediation strategies, please refer to the *Guide to Ground Water Remediation at CERCLA Response Action and RCRA Corrective Action Sites* (DOE/EH-0505, October 1995), [http://www.eh.doe.gov/oepa under "Policy & Guidance"].

Exhibit 4-1
Summary of Chapter Sections

Section	Contents
4.1 - Summary of Major Requirements (page 4-1)	Overview of Main Messages
4.2- Summary of Ground Water Management Technologies (page 4-3)	Includes descriptions, information on amount of waste generated, residual waste generated, and follow-on activities for a variety of treatment technologies
4.3 - Basic Management Requirements During Pre-Treatment, Treatment, and Post-Treatment Phases for Hazardous Wastes (page 4-3)	Discusses regulations that are triggered as a result of different management strategies for hazardous wastes that are generated as environmental restoration wastes
4.4 - Basic Management Requirements During Pre-Treatment, Treatment, and Post-Treatment Phases for Radioactive Wastes (page 4-18)	Discusses regulations that are triggered as a result of different management strategies for radioactive wastes that are generated as environmental restoration wastes
4.5 - Basic Management Requirements During Pre-Treatment, Treatment, and Post-Treatment Phases for Mixed Wastes (page 4-22)	Discusses regulations that are triggered as a result of different management strategies for mixed wastes that are generated as environmental restoration wastes
4.6 - Alternate Compliance Options (Page 4-23)	Discusses a variety of alternatives for meeting regulatory requirements

4.1 Summary of Major Requirements For Ground Water

The following are the main points explained in detail in this chapter:

- Ground water contaminated with a listed hazardous waste is considered hazardous under the "contained in" policy or may be hazardous if it exhibits a characteristic of a hazardous waste. As long as ground water exhibits the characteristic of a hazardous waste or "contains" the listed waste, it must be managed as a hazardous waste and is subject to the restrictions of either RCRA Subtitle C or the more stringent requirements of an authorized state program.

The "contained-in policy" was first articulated by EPA in 1986 and is the basis for regulating ground water as hazardous wastes. Many states have their own policies. More information can be found in the EH-413 menorandum, *Management of Remediation Waste Under RCRA*, December 21, 1999, http://www.eh.doe.gov/oepa under "Policy & Guidance" and in Chapter 3.

- Ground-water management strategies can be classified into three general types of management approaches, each of which leads project managers to consider different types of environmental restoration waste requirements: (1) monitored natural attenuation, (2) active in-situ treatment (e.g., bioremediation, in-situ well stripping) , or (3) ex-situ management (e.g., extraction, treatment, and discharge). For example, during monitored natural attenuation, environmental restoration wastes are seldom generated, and the focus is on monitoring to ensure the attenuation is occurring as predicted. During active in-situ management approaches, the focus is also on monitoring the performance of the remedy but project managers also must determine how to manage any treatment residuals (e.g., vapors) generated during treatment. During ex-situ management, the focus of environmental restoration waste management is on complying with the regulatory requirements applicable to both the water extracted and any wastes generated as residuals from treatment.

"Generated" is a RCRA concept meaning a waste is subject to regulatory requirements because regeneration of previously disposed or discharged waste is considered to be the same as "generation."

Ex-situ management options are discussed in detail beginning on page 4-15.

- During ex-situ treatments, the contaminated ground water extracted from the subsurface can be treated, and either (1) reinjected into an aquifer, (2) discharged under a NPDES permit, (3) sent to a Publicly Owned Treatment Works (POTW) or Federally Owned Treatment Works (FOTW), or (4) sent to an on-site wastewater treatment plant. Each of these discharge options impose different environmental restoration waste handling requirements (which are explained in the appropriate sections of this Chapter).

DOE M 435.1-1 (July 1999) describes radioactive and mixed waste management requirements. Mixed waste management requirements are addressed specifically in sections III B(1) (for transuranic wastes), and IV B(1) (for low-level wastes). [http://www.explorer.doe.gov:1776/htmls/currentdir.html]

- Ground water containing radionuclides, or radionuclides and hazardous wastes (mixed wastes), will be subject to radioactive waste management or mixed waste requirements, respectively depending on how the ground water is managed during a remediation.

- DOE's requirements for remediating releases of radionuclides to

Chapter 5
Management of Contaminated Soil During Environmental Restoration Projects

This chapter describes the requirements for managing soil when it is an environmental restoration waste contaminated with hazardous or radioactive wastes (or mixed wastes). Because of the many physical similarities between soils and sediments, and similar management options used to manage soils and sediments that are dredged, this chapter also applies to contaminated sediments. The chapter is organized as outlined in Exhibit 5-1.

Environmental restoration wastes include contaminated soils that are managed during a response action, including residuals from that management, and any residuals produced during in-situ management.

Exhibit 5-1
Summary of Chapter Sections

Section	Contents
5.1 Summary of Major Requirements (page 5-2)	Overview of main messages.
5.2 Concepts and Definitions (page 5-3)	Definitions of terms and key concepts used throughout the chapter.
5.3 Summary of Soil Treatment Technologies (page 5-5)	Brief technology descriptions and residual wastes typically generated for a variety of treatment technologies.
5.4 Basic Management Requirements During Pre-Treatment, Treatment, and Post-Treatment Phases for Hazardous Soil Environmental Restoration Wastes (page 5-5)	Discusses requirements and management strategies for hazardous soils that are environmental restoration wastes.
5.5 Basic Management Requirements During Pre-Treatment, Treatment, and Post-Treatment Phases for Radioactive Soil Environmental Restoration Wastes (page 5-24)	Discusses requirements and management strategies for radioactively contaminated soils that are environmental restoration wastes.
5.6 Basic Management Requirements During Pre-Treatment, Treatment, and Post-Treatment Phases for Mixed Waste (page 5-32)	Discusses requirements and management strategies for mixed waste soils that are environmental restoration wastes.
5.7 Managing PCB- and Asbestos-Containing Soil Wastes (page 5-32)	Discusses requirements associated with managing contaminated PCB and asbestos-containing soil wastes.
5.8 Compliance Options for Managing Soil Environmental Restoration Wastes (page 5-34)	Discusses a variety of alternatives for meeting regulatory requirements.

Additional guidance on managing contaminated sediments can be found from several sources including: *Contaminated Sediment Management Strategy*, EPA823-R-98-001, April 1998; *Handbook - Remediation of Contaminated Sediments*, EPA/625/6-91/028, April, 1991; and *National Conference on Management and Treatment of Contaminated Sediments*, EPA/625/R-98/001, August 1998.

5.1 Summary of Major Requirements

The major requirements affecting soils that are generated as environmental restoration wastes during a response action are the following.

EPA defines placement to include excavation and management of wastes in another "unit." Placement does not include consolidation within an area of contamination, capping in place, or in-situ treatment.

- The main regulatory drivers that determine how project managers must manage soil environmental restoration wastes that contain listed wastes or exhibit a characteristic of a hazardous waste are those requirements that determined to be applicable or relevant and appropriate requirements (ARARs) under CERCLA, or requirements that must be met during and at the conclusion of a RCRA corrective action. These primarily are the Land Disposal Restrictions (LDRs) under RCRA or equivalent State programs; handling requirements that apply while wastes are being managed; and operating requirements for units in which these wastes are managed.

- Because EPA has established presumptive remedies for several types of soil remediation projects, it is possible to determine the likely technologies that will be used for soil remediation early in the planning of a response action and, therefore, begin to anticipate issues with management of contaminated soil. Exhibit 5-2 summarizes the presumptive remedies that EPA has established for different types of contaminants in soils.

Universal treatment standards (UTS) are promulgated by EPA for each hazardous constituent in 40 CFR 268. Different standards are established for waste waters and non-waste waters.

- In 1998, EPA promulgated specific LDR treatment standards for contaminated soils (63 FR 28605, May 26, 1998). These standards require either compliance with the original (process waste) treatment standards or reduction in concentrations of underlying hazardous constituents reasonably expected to be present at 10 times their universal treatment standard. The standard established is reduction by 90 percent with the treatment for any given constituent capped at 10 times the universal treatment standard.

- As part of the 1998 Phase IV LDR rulemaking, EPA also established a site-specific, risk-based, "minimize threats" variance that may be appropriate to consider for low concentrations of contaminants in soils. This variance allows contaminated soil to no longer be subject to RCRA Subtitle C requirements.

Exhibit 5-2
EPA Presumptive Remedies for Contaminated Soils

Presumptive Remedy	Presumptive Technologies	Reference
Volatile organic compounds (VOCs) in Soils	▸ Soil Vapor Extraction (SVE) ▸ Thermal Desorption ▸ Incineration	EPA Directive 9355.0-48FS; EPA 540-F-93-048; PB 93-9633346 September 1993
Metals in Soils	Principal Threats ▸ Recovery/ reclamation, or ▸ Immobilization Low Level Threat Wastes ▸ Containment	EPA Directive 9355.0-72FS; EPA 540-F-98-054; PB99-963301 September 1999
Wood Treaters (semi-volatile contaminants such as Polynuclear Aromatic Hydrocarbons)	▸ Bioremediation ▸ Thermal Desorption ▸ Incineration ▸ Immobilization	EPA Directive 9200.5-162; EPA/540/R-95/128; PB 95-963410 December 1995

- The requirements for managing radioactive soil wastes are largely specified in DOE Order 435.1 for Radioactive Waste Management and is accompanying Manual.

- For remediation projects where wastes will be sent to an existing management facility, the WAC for the receiving facility define many of the conditions that must be met to properly handle and transport the radioactive waste.

This includes formal WAC and requirements contained in permits and operating procedures.

- If project managers will construct new radioactive waste facilities as part of a remediation project, the DOE Order and Manual contain detailed design and performance criteria that must be met.

5.2 Concepts and Definitions

There are several key concepts and definitions critical to understanding how to manage hazardous soil, several of which EPA newly introduced as part of its 1998 Phase IV LDR rulemaking that specifically established treatment standards for contaminated soil:

For definitions of listed and characteristic hazardous waste, see Chapter 3: Characterization of Environmental Restoration Wastes.

Soil means materials that are primarily of geologic origin such as sand, silt, loam, or clay that are indigenous to the natural geologic environment. It is important to note that CERCLA defines soil as having a particle size under two millimeters, while the RCRA defines soil as having a particle size under nine millimeters.

These definitions are established or clarified in the 1998 Phase IV LDR rulemaking (63 FR 28605, May 26, 1998).

Hazardous soil means soil that either contains listed waste or exhibits a characteristic of hazardous waste.

Contaminated soil means soil (as defined above) that is both hazardous contaminated soil (soil that contains a listed hazardous waste or exhibits a characteristic of hazardous waste) and other soil (such as decharacterized soil) that may be subject to the LDRs.

Principles for Evaluating When LDRs Apply to Contaminated Soils. EPA relies on three principles when evaluating the potential applicability of LDRs to contaminated soil:

EPA re-emphasized these principles in the preamble to the recent Phase IV LDR rulemaking.

1. Land disposal restrictions only attach to prohibited hazardous waste (or hazardous contaminated soil) when it is (a) generated and (b) placed in a land disposal unit.

2. Once a decision has been made to generate and re-dispose contaminated soils on land, LDRs generally only apply to contaminated soils that contain hazardous wastes (unless a regulatory option, such as a corrective action management unit, is used).

3. Once LDRs attach (generally at the point of generation, See principle 1), to any given hazardous waste or volume of hazardous contaminated soil, the LDR treatment standards continue to apply until they are met.

Timing for evaluating LDRs. **Because of their potential impacts and inherent complexities, it is extremely important to determine whether soil wastes generated during a CERCLA remedial action or RCRA corrective action is subject to LDRs as early as possible in the Remedial Investigation/Feasibility Study (RI/FS) or Remedial Field Investigation/Corrective Measures Study (RFI/CMS) process**. Compliance with LDRs may affect the ability to land dispose of restricted wastes, and, therefore, may end up representing a major uncertainty for the entire project if not evaluated sufficiently. Because of the requirements to conduct treatment for many soil wastes for all underlying hazardous constituents reasonably expected to be present at more than 10 times the universal treatment standard, LDR issues may be a significant problem and require early evaluation even for soil contaminated with low concentrations of hazardous constituents.

5.3 Summary of Soil Treatment Technologies

Because the regulatory requirements for soils that are environmental restoration wastes differ significantly depending on what technologies are selected and what residuals are generated, it is important for project managers to identify potentially appropriate technologies early in project planning. Exhibit 5-3, therefore, briefly describes some of the more common in-situ treatment technologies for hazardous soil and the resulting waste residuals (and do not attempt to suggest which technologies are better or more feasible to use). From a remediation waste management perspective, the main advantage of in-situ treatment is that it allows soil to be treated without being excavated and transported, resulting in potentially significant cost savings. However, in-situ treatment generally requires longer time periods, and there is less certainty about the uniformity of treatment because of the variability in soil and because the efficacy of the process is more difficult to verify.

For extensive information on soil treatment technologies, see the *Remediation Technologies Screening Matrix and Reference Guide*, Version 3.0, on the Federal Remediation Technologies Roundtable homepage at www.frtr.gov.

Exhibit 5-4 briefly describes some of the more common ex-situ treatment technologies for hazardous soil and the resulting waste residuals. The main advantage of ex-situ treatment is that it generally requires shorter time periods, and there is more certainty about the uniformity of treatment because of the ability to homogenize, screen, and continuously mix the soil. However, ex-situ treatment requires excavation of soils, leading to increased costs and engineering for equipment, possible permitting, and material handling/worker exposure considerations.

Exhibit 5-5 briefly describes the potentially available technologies for radioactively contaminated soils.

Wastes that are not managed during a response action (i.e., those left in place) are not environmental restoration wastes (see Chapter 1, Section 1.2). However, wastes that are capped in place or treated in place are considered to be "managed" and, therefore, are included in this *Guide*.

5.4 Basic Management Requirements During Pre-Treatment, Treatment, and Post-Treatment Phases for Hazardous Soil Environmental Restoration Wastes

The waste handling requirements for soils that are a hazardous environmental restoration waste differ in large part on whether technologies are implemented in-situ or ex-situ (e.g., whether or not they involve excavation and placement of wastes). This chapter describes management requirements for both in-situ and ex-situ management during pre-treatment, treatment, and post-treatment phases of a project.

Requirements apply to CERCLA actions to the degree they are applicable or relevant and appropriate. In some cases, the RCRA interim status requirements of 40 CFR 265 may be deemed relevant and appropriate rather than those outlined in 40 CFR 264.

5.4.1 In-Situ Management - Soils Managed as Hazardous Waste

For in-situ management approaches, the primary requirements governing management of environmental restoration wastes focus on proper management of any waste residuals generated and on proper closure and monitoring of the waste “unit” itself that contains the contaminated soil. Exhibit 5-6 summarizes potentially applicable RCRA standards for these types of response actions.

Exhibit 5-3: In-Situ Treatment Technologies Typically Available for Hazardous Contaminated Soil

Treatment Technology	Brief Technology Description	Applicable Contaminants	Residual Waste Generated
BIOLOGICAL TREATMENT			
Bioventing	Oxygen is delivered to contaminated unsaturated soils by forced air movement (either extraction or injection of air) to increase oxygen concentrations and stimulate biodegradation.	Bioventing techniques have been successfully used to remediate soils contaminated by petroleum hydrocarbons, nonchlorinated solvents, some pesticides, wood preservatives, and other organic chemicals.	Although bioventing cannot degrade inorganic contaminants, it may stabilize or remove inorganics by adsorption, uptake, accumulation, and concentration in micro and macroorganisms.
Enhanced Biodegradation	The activity of naturally occurring microbes is stimulated by circulating water-based solutions through contaminated soils to enhance in-situ biological degradation of organic contaminants. Nutrients, oxygen, or other amendments may be used to enhance biodegradation and contaminant desorption from subsurface materials.	Bioremediation techniques have been successfully used to remediate soils contaminated with petroleum hydrocarbons, solvents, pesticides, wood preservatives, and other organic chemicals.	Bioremediation cannot degrade inorganic contaminants, but it may stabilize or remove inorganics by adsorption, uptake, accumulation, and concentration in micro and macroorganisms.
Land Treatment	Contaminated surface soil is treated in place by tilling to achieve aeration, and if necessary, by addition of amendments. Periodic tilling, to aerate the waste, enhances the biological activity.	Land treatment has been proven successful in treating petroleum hydrocarbons and other less volatile, biodegradable contaminants.	Land treatment cannot degrade inorganic contaminants, but it may stabilize or remove inorganics by adsorption, uptake, accumulation, and concentration in micro and macroorganisms. The more chlorinated or nitrated the compound, the more difficult it is to degrade.

Treatment Technology	Brief Technology Description	Applicable Contaminants	Residual Waste Generated
Natural Attenuation	Natural subsurface processes - such as dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials - are allowed to reduce contaminant concentrations to acceptable levels.	Target contaminants for natural attenuation are VOCs, SVOCs, and petroleum hydrocarbons. Pesticides can also be allowed to naturally attenuate, but the process may be less effective and may be applicable to only some compounds within the group.	Natural attenuation cannot degrade inorganic contaminants, but it may stabilize or remove inorganics by adsorption, uptake, accumulation, and concentration in micro and macroorganisms. Some metals may be only temporarily immobilized with remobilization occurring when natural attenuation re-establishes oxygenated soil conditions.
Phytoremediation	Phytoremediation is a set of processes that use plants to clean contamination in soil, ground water, surface water, sediment, and air.	Phytoremediation may be applicable for the remediation of metals, pesticides, solvents, explosives, crude oil, Polycyclic Aromatic Hydrocarbons (PAHs), and landfill leachate.	Phytoremediation is not effective for some inorganics or strongly-sorbed (e.g., PCBs) and weakly sorbed contaminants. Contaminants in deeper soils will be left in place because the depth of the treatment zone is dependent upon the type(s) of plants used in the phytoremediation process.
PHYSICAL/CHEMICAL TREATMENT			
Electrokinetic Separation	The Electrokinetic Remediation (ER) process removes metals and organic contaminants from low permeability soil, mud, sludge, and marine dredging. ER uses electrochemical and electrokinetic processes to desorb, and then remove, metals and polar organics. This in-situ soil processing technology is primarily a separation and removal technique for extracting contaminants from soils.	Targeted contaminants for electrokinetic separation are heavy metals, anions, and polar organics in soil.	Oxidation/reduction reactions cannot be used on petroleum hydrocarbons. In addition, the ER process may facilitate the formation of undesirable products, such as chlorine gas.
Fracturing	Pressurized air is injected beneath the surface to develop cracks in low permeability and over-consolidated sediments, opening new passageways that increase the effectiveness of many in situ processes and enhance extraction efficiencies.	Fracturing is applicable to the complete range of contaminant groups, with no particular target group.	The potential exists to open new pathways for the unwanted spread of contaminants (e.g., DNAPLs).

Treatment Technology	Brief Technology Description	Applicable Contaminants	Residual Waste Generated
Soil Flushing	Water, or water containing an additive to enhance contaminant solubility, is applied to the soil or injected into the ground water to raise the water table into the contaminated soil zone. Contaminants are leached into the ground water, which is then extracted and treated.	The target contaminant group for soil flushing is inorganics, including radioactive contaminants. This technology may be used to treat VOCs, SVOCs, fuels, and pesticides, but it may be less cost-effective than alternative technologies for these contaminants.	The addition of environmentally compatible surfactants may be used to increase the solubility of some organic compounds; however, the flushing solution may alter the physical/chemical properties of the soil.
Soil Vapor Extraction	Vacuum is applied through extraction wells to create a pressure/concentration gradient that induces gas-phase volatiles to diffuse through soil to extraction wells. The process includes a system for handling off-gases. This technology also is known as in-situ soil venting, in-situ volatilization, enhanced volatilization, or soil vacuum extraction.	The target contaminant groups for in-situ soil vapor extraction are VOCs and some fuels. Because the process involves the continuous flow of air through the soil, it often promotes biodegradation of low-volatility organic compounds that may be present.	In-situ soil vapor extraction will not remove inorganics, heavy oils, metals, PCBs, or dioxins from the soil.
Solidification/Stabilization	Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization).	The target contaminant group for in-situ solidification/stabilization is generally inorganics, including radionuclides. The technology can destroy or remove some organics and immobilize most inorganics in contaminated soils.	Solidification/stabilization has had limited effectiveness against SVOCs, and pesticides and no effectiveness against VOCs and most fuels; however, systems designed to be more effective in treating organics are currently being developed and tested.
THERMAL TREATMENT			
Thermally Enhanced Soil Vapor Extraction (SVE)	Steam/hot air injection or electromagnetic/fiber optic/radio frequency/electrical conduction heating is used to increase the mobility of volatiles and facilitate extraction. The process includes a system for handling off-gases.	This system is designed to treat SVOCs but will consequently treat VOCs. Thermally enhanced SVE technologies are also effective in treating some pesticides and fuels, depending on the temperatures achieved by the system.	Thermally enhanced SVE will not remove inorganics, heavy oils, metals, PCBs, or dioxins from the soil. After application of this process, subsurface conditions are excellent for biodegradation of residual contaminants.
OTHER TREATMENT			

Treatment Technology	Brief Technology Description	Applicable Contaminants	Residual Waste Generated
Containment *(is a good treatment technology in these circumstances)*	Containment includes vertical or horizontal barriers. It can provide sustained isolation of contaminants and prevent mobilization of soluble compounds over long periods of time. It also reduces surface water infiltration, controls odor and gas emissions, provides a stable surface over wastes, and limits direct contact.	Containment generally is ammenable to most types of contaminants, though it is not as effective at sites with a high ground-water table or sites located on a floodplain.	Containment does not involve treatment, reduce toxicity or waste volume, and will generally restrict future uses of a site.

Exhibit 5-4: Ex-Situ Treatment Technologies for Hazardous Contaminated Soil

Treatment Technology	Brief Technology Description	Applicable Contaminants	Residual Waste Generated
BIOLOGICAL TREATMENT			
Biopiles	Excavated soils are mixed with soil amendments and placed in above ground enclosures. Processes include prepared treatment beds, biotreatment cells, soil piles, and composting.	Biopile treatment is successful treating nonhalogenated VOCs and fuel hydrocarbons.	Halogenated VOCs, SVOCs, and pesticides can also be treated, but the process effectiveness will vary and may be applicable only to some compounds within these contaminant groups. Inorganic contaminants cannot be treated using this technology.
Composting	Contaminated soils are excavated and mixed with bulking agents and organic amendments such as wood chips, animal and vegetative wastes, which are added to enhance the porosity and organic content of the mixture to be decomposed.	The composting process may be applied to soils contaminated with biodegradable organic compounds.	Although levels of metals may be reduced via dilution, heavy metals are not treated by this method. Inorganic contaminants cannot be treated using this method. In addition, excavation of contaminated soils may cause the uncontrolled release of VOCs.
Fungal Biodegradation	Fungal biodegradation refers to the biodegradation of a wide variety of organopollutants by using their lignin-degrading or wood rotting enzyme system.	This technology has the ability to degrade and mineralize a number of organopollutants and the potential to degrade and mineralize other recalcitrant materials, such as DDT, PAH, and PCB.	This technology generally does not degrade contaminants to levels sufficient to meet cleanup standards. In addition, inorganic contaminants cannot be treated by this technology.
Landfarming	Contaminated soils are applied onto the soil surface and periodically turned over or tilled into the soil to aerate the waste.	Landfarming has been proven successful in treating petroleum hydrocarbons and other less volatile, biodegradable contaminants.	While landfarming cannot degrade inorganic contaminants, it may stabilize or remove inorganics by adsorption, uptake, accumulation, and concentration in micro and macroorganisms. The more chlorinated or nitrated the compound, the more difficult it is to degrade.

Treatment Technology	Brief Technology Description	Applicable Contaminants	Residual Waste Generated
Slurry Phase Biological Treatment	An aqueous slurry is created by combining soil or sludge with water and other additives. The slurry is mixed to keep solids suspended and microorganisms in contact with the soil contaminants. Upon completion of the process, the slurry is dewatered and the treated soil is disposed of.	Slurry phase biological treatment has been used to successfully remediate soils contaminated by PCBs, petroleum hydrocarbons, petrochemicals, solvents, pesticides, wood preservatives, and other organic chemicals.	Soils containing inorganic contaminants will not be remediated using slurry phase biological treatment techniques.
PHYSICAL/CHEMICAL TREATMENT			
Chemical Extraction	Waste contaminated soil and extractant are mixed in an extractor, dissolving the contaminants. The extracted solution is then placed in a separator, where the contaminants and extractant are separated for treatment and further use.	Chemical extraction technologies have been effective in treating soils containing primarily organic contaminants, such as PCBs, VOCs, halogenated solvents, and petroleum waste, as well as heavy metals.	Inorganics can be treated using chemical extraction technologies, but levels are commonly not reduced below regulatory cleanup levels. In addition, traces of solvents may remain in the treated soil after chemical extraction.
Chemical Reduction/Oxidation	Reduction/oxidation chemically converts hazardous contaminants to non-hazardous or less toxic compounds that are more stable, less mobile, and/or inert. The oxidizing agents most commonly used are ozone, hydrogen peroxide, hypochlorites, chlorine, and chlorine dioxide.	The target contaminant group for chemical oxidation/reduction is inorganics. This technology can be used, but may be less effective, against nonhalogenated VOCs and SVOCs, fuel hydrocarbons, and pesticides.	Incomplete oxidation or formation of intermediate contaminants may occur depending upon the contaminants and oxidizing agents used.
Dehalogenation	Reagents are added to soils contaminated with halogenated organics. The dehalogenation process is achieved by either the replacement of the halogen molecules or the decomposition and partial volatilization of the contaminants.	Halogenated VOCs and SVOCs, PCBs, and pesticides are the target contaminant groups for dehalogenation treatment.	Inorganics, halogenated VOCs and SVOCs, and fuels cannot be treated using dehalogenation technologies.

Treatment Technology	Brief Technology Description	Applicable Contaminants	Residual Waste Generated
Recovery/Reclamation	Reclamation/recovery is a permanent treatment that separates metal contaminants from soil in the form of metal, metal oxide, ceramic product, or other useful products that have potential market value. Reclamation/recovery may be the primary treatment and may include hydrometallurgical or leaching processes. Compounds in waste can also be converted to metal or matte by transferring undesirable components to a separate slag phase.	Reclamation/recovery often is amenable to situations with high concentrations of valuable or easily volatized materials. For zinc, lead, cadmium, nickel, and chromium it may be economically viable to recover metals from large volumes of waste with high concentrations at 5-20%. Additionally, proven technology exists for recovering material containing greater than 40% lead.	Subsequent treatment can be performed to upgrade the metal or matte. Further management of materials left over may be required to protect human health and the environment once metals are recovered.
Separation	Separation techniques concentrate contaminated solids through physical and chemical means. These processes seek to detach contaminants from their medium (i.e., the soil, sand, and/or binding material that contains them).	The target contaminant groups for ex-situ separation processes are organics and inorganics, including radionuclides. These technologies can be used on selected VOCs and pesticides.	Most organic contaminants, such as SVOCs, fuels, and VOCs, cannot be treated using separation techniques.
Soil Washing	Contaminants sorbed onto fine soil particles are separated from bulk soil in an aqueous-based system on the basis of particle size. The wash water may be augmented with a basic leaching agent, surfactant, pH adjustment, or chelating agent to help remove organics and heavy metals.	Heavy metals, fuels, and SVOCs are the target contaminant groups for soil washing. The technology can also be used on selected VOCs and pesticides.	Many organics will be difficult to remove using soil washing technologies. In addition, the contaminated water from soil washing will need to be treated with the technology(s) suitable for the contaminants.
Soil Vapor Extraction	A vacuum is applied to a network of above ground piping to encourage volatilization of organics from the excavated media. The process includes a system for handling off-gases.	The target contaminant groups for ex-situ soil vapor extraction are VOCs, SVOCs, and fuels.	Ex-situ SVE cannot be used to treat inorganic contaminants. In addition, air emissions, residual liquid, and spent activated carbon will require treatment.
Solar Detoxification	Solar detoxification is a process that destroys contaminants by using the ultraviolet energy in sunlight.	Dyes, solvents, pesticides, VOCs, and SVOCs have all been successfully treated using solar detoxification technologies.	Inorganics cannot be treated using solar detoxification technologies.
Solidification/Stabilization	Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization).	The target contaminant group for ex-situ solidification/stabilization is inorganics, including radionuclides.	Most solidification/stabilization technologies have limited effectiveness against organics and pesticides.

Treatment Technology	Brief Technology Description	Applicable Contaminants	Residual Waste Generated
THERMAL TREATMENT			
Incineration	High temperatures, 871-1,204 °C (1,600- 2,200 °F), are used to combust (in the presence of oxygen) organic constituents in hazardous wastes.	Incineration is used to remediate soils contaminated with hazardous waste, particularly chlorinated hydrocarbons, PCBs, and dioxins.	Metals may produce bottom ash that requires stabilization, leave the combustion unit with flue gases and require installation of a gas cleaning system, or react with other elements to form more volatile and toxic compounds than the original species. Inorganics cannot be treated using incineration techniques.
Pyrolysis	Chemical decomposition is induced in organic materials by heat in the absence of oxygen. Organic materials are transformed into gaseous components and a solid residue (coke) containing fixed carbon and ash.	The target contaminant groups for pyrolysis are SVOCs and pesticides.	Pyrolysis is not effective in either destroying or physically separating inorganics from contaminated media. Volatile metals may be removed as a result of the higher temperatures associated with the process but are similarly not destroyed.
Thermal Desorption	Wastes are heated to volatilize water and organic contaminants. A carrier gas or vacuum system transports volatilized water and organics to the gas treatment system.	Thermal desorption systems have varying degrees of effectiveness against the full spectrum of organic contaminants.	Heavy metals in the feed may produce a treated solid residue that requires stabilization.

Exhibit 5-5: Treatment Technologies for Soil Contaminated with Radioactive Waste

Treatment Technology	Brief Technology Description	Applicable Contaminants	Residual Waste Generated
IN-SITU TREATMENT TECHNOLOGIES			
Natural Attenuation	Natural subsurface processes - such as dilution, volatilization, biodegradation, adsorption, and chemical reactions with subsurface materials - are allowed to reduce contaminant concentrations or activity to acceptable levels.	Target contaminants for natural attenuation are VOCs, SVOCs, and petroleum hydrocarbons. Pesticides can also be allowed to naturally attenuate, but the process may be less effective and may be applicable to only some compounds within the group.	While natural attenuation cannot degrade inorganic contaminants, including radionuclides, it may stabilize or remove inorganics by adsorption, uptake, accumulation, and concentration in receptors. This allows radionuclides to decay in place, with little or no migration.
Soil Flushing	Water, or water containing an additive to enhance contaminant solubility, is applied to the soil or injected into the ground water to raise the water table into the contaminated soil zone. Contaminants are leached into the ground water, which is then extracted and treated.	The target contaminant group for soil flushing is inorganics, including radioactive contaminants. This technology may be used to treat VOCs, SVOCs, fuels, and pesticides, but it may be less cost-effective than alternative technologies for these contaminants.	The addition of environmentally compatible surfactants may be used to increase the solubility of some organic compounds; however, the flushing solution may alter the physical/chemical properties of the soil.
Solidification/Stabilization	Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization).	The target contaminant group for in-situ solidification/stabilization is generally inorganics, including radionuclides. The technology can destroy or remove some organics and immobilize most inorganics in contaminated soils.	Solidification/stabilization has had limited effectiveness against SVOCs, and pesticides and no effectiveness against VOCs and most fuels; however, systems designed to be more effective in treating organics are currently being developed and tested.

Treatment Technology	Brief Technology Description	Applicable Contaminants	Residual Waste Generated
EX-SITU TREATMENT TECHNOLOGIES			
Separation	Separation techniques concentrate contaminated solids through physical and chemical means. These processes seek to detach contaminants from their medium (i.e., the soil, sand, and/or binding material that contains them).	The target contaminant group for ex-situ separation processes is inorganics, including radionuclides. These technologies can be used on selected VOCs and pesticides.	Most organic contaminants, such as SVOCs, fuels, and VOCs, cannot be treated using separation techniques.
Soil Washing	Contaminants sorbed onto fine soil particles are separated from bulk soil in an aqueous-based system on the basis of particle size. The wash water may be augmented with a basic leaching agent, surfactant, pH adjustment, or chelating agent to help remove organics and heavy metals.	Heavy metals, fuels, SVOCs, and inorganic contaminants, including radionuclides, are the target contaminant groups for soil washing. The technology can also be used on selected VOCs and pesticides.	Many organics will be difficult to remove using soil washing technologies. In addition, the contaminated water form soil washing will need to be treated with the technology(s) suitable for the contaminants.
Solidification/Stabilization	Contaminants are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and contaminants to reduce their mobility (stabilization).	The target contaminant group for ex-situ solidification/stabilization is inorganics, including radionuclides.	Most solidification/stabilization technologies have limited effectiveness against organics and pesticides.

Exhibit 5-6: Potentially Applicable RCRA Standards For In-Situ Response Actions

Standard	Brief Description
Management of Waste Residuals	Waste residuals may be produced through such in-situ remedies as soil vapor extraction and other technologies that separate contaminants from the soil media. In these cases, the waste residuals may have to be evaluated against the following types of requirements: • Determination of waste status (e.g., RCRA waste generator requirements in 40 CFR 262 and characterization requirements, see Chapter 3); • Handling requirements when generated before final disposition (e.g., proper storage, packaging, and transportation in accordance with 40 CFR 262 and 40 CFR 263); and • Proper treatment and disposition (e.g., in accordance with any LDR restrictions and allowable operating and permit conditions of a receiving facility).
Groundwater Monitoring (40 Part 264, Subpart F)	Additional RCRA standards may be applicable to hazardous waste land disposal units at CERCLA sites. RCRA groundwater monitoring standards are applicable when a Superfund response involves the creation of a new land disposal unit or the remediation of an existing land disposal unit.
Closure and Post Closure (Part 264, Subpart G)	RCRA closure and post-closure requirements often are applicable to hazardous waste management units that are used for disposal at Superfund or RCRA corrective action sites. There are two types of potentially applicable RCRA closure schemes: clean closure and landfill closure. Clean closure involves removing or decontaminating all waste residues, contaminated equipment, and contaminated soils so that no additional care or monitoring is required. Landfill closure involves leaving hazardous waste and contaminated waste equipment in place and may trigger applicable requirements such as the use of a final cap or cover for the unit and continued groundwater monitoring in the post-closure period.

Note: Similar standards under authorized State programs may apply in lieu of Federal RCRA requirements

5.4.2 Ex-Situ Management - Soils Managed as Hazardous Waste

Environmental restoration soil wastes that are managed ex-situ are subject to a much more comprehensive set of requirements than those managed through in-situ methods because they trigger regulations that apply only when wastes are land disposed or placed following excavation (the only exception is if wastes remain within an area of contamination, in which case EPA determines that "placement" has not occurred). This section describes the major requirements that apply during the initial handling and staging of ex-situ managed wastes, as well as those requirements that typically apply during any treatment and final disposal activities.

Requirements During Initial Handling of Soil Wastes

Excavated soil can be managed through a variety of different management approaches including 1) immediate packaging and shipping to a facility for subsequent management; 2) staging near the source of excavation until final management plans are implemented; 3) staging elsewhere on a site until final management plans are implemented; or 4) treatment near the source of excavation and final disposition either in the original location or in an on- or off-site disposal facility.

Environmental restoration management requirements vary substantially depending on the configuration of the management options selected, the permitted status of the site, and any variances of alternate approaches that will be used as part of this process (e.g., use of a corrective action management unit (CAMU)). This section describes the basic management requirements in the areas of transport, compliance assurance, and permitting. Section 5.8 describes available compliance options that are available and may be incorporated as a part of a site's management strategy.

Transport

Wastes transported off-site are subject to both RCRA and DOT regulations. Wastes transported on-site are subject to restrictions outlined in the facility permit.

When the waste is being transported to an off-site treatment facility the field manager must comply with the manifest requirements of 40 CFR 262 or an equivalent State program, which include:

- Identification of the hazardous waste (40 CFR 262.11);
- Identifying the TSD facility, transportation mode, and company handling the waste (40 CFR 262.12);
- Properly packaging the waste (40 CFR 262.30);
- Abiding by labeling, marking, and placarding requirements (40 CFR 262.30 -262.33); and
- Completing and signing the manifest (40 CFR 262.20 -262.23).

The requirements for the transporter of the waste are identified in 40 CFR 263. In developing these regulations, EPA adopted most of the DOT's requirements for transporting hazardous waste (49 CFR 171 - 179). A transporter should also refer to the DOT regulations to ensure they are in compliance. For example, the Hazardous Materials Table in

49 CFR 172.101 identifies wastes that are forbidden from transport as well as wastes that are restricted to particular modes of transportation.

If soil contaminated with hazardous waste will only be transported to an on-site treatment facility (on non-public roads), the RCRA transporter requirements are not triggered. On-site transport restrictions or procedures, however, may be included in the RCRA permit or implementation plan that require that RCRA and DOT requirements be met.

Storage

Sites that are storing hazardous contaminated soil (e.g., during staging activities) have to meet the applicable or relevant and appropriate unit-specific requirements corresponding to the unit being used (e.g., container, tank, waste pile). Requirements that typically apply to these types of storage requirements are included in Exhibit 5-7.

Sites may also rely on a staging pile, a new unit defined in the recent HWIR-Media rule, or a temporary unit, established in 1993. See Section 5.8.2 and 5.8.8 of this *Guide* for more information.

Exhibit 5-7
Waste Specific Design and Operating Requirements

Storage Unit	Design and Operating Requirements
Containers - "any portable device in which material is stored, transported, treated, disposed of, or otherwise handled." (40 CFR 260.10)	The following general requirements apply to containers: • Must be in good condition; • Wastes must be compatible; • Containers must be closed during storage; • Container areas must have a containment system; and • Special requirements must be met for ignitable, reactive, and incompatible wastes [See 40 CFR 264 Subpart I]

In some cases, project managers may determine the requirements of 40 CFR 265 for interim status facilities are more appropriate to meet than those for permitted facilities.

Additional information on container management may be found in "Management of Hazardous Waste Containers & Container Storage Areas under RCRA", DOE/EH-0333, August 1993, [http://www.eh.doe.gov/oepa/ under "Policy and Guidance"].

Storage Unit	Design and Operating Requirements
Tanks - "a stationary device, designed to contain an accumulation of hazardous waste which is constructed primarily of non-earthen materials (e.g., wood, concrete, steel, plastic) which provide structural support." (40 CFR 260.10)	The following general requirements apply to tanks: • Must meet design and operating requirements specified in 40 CFR 264.192; • Must have containment and systems to detect releases; • Must comply with general operating requirements such as spill prevention; • Must be inspected routinely; and • Must meet special requirements for ignitable, reactive, or incompatible wastes [See 40 CFR 264 Subpart J]
Waste Piles - "any non-containerized accumulation of solid, nonflowing hazardous waste that is used for treatment or storage and that is not a containment building." (40 CFR 260.10)	The following general requirements apply to waste piles: • Must meet design and operating requirements, including a liner designed to prevent migration of wastes, leachate collection and removal system, and leak detection system; • Must be monitored and inspected; and • Must meet special requirements for ignitable, reactive, and incompatible wastes

Note: Similar standards under authorized State programs may apply in lieu of Federal RCRA requirements

Waste accumulation and storage requirements change if the site uses a CAMU or TU. The applicability of CAMUs and TUs in managing contaminated soil is discussed in Section 5.8.

For additional information on tank management see "Resource Conservation and Recovery Act Hazardous Waste Tank Systems", DOE/EH-413/9716, September 1997, [http://www.eh.doe.gov/oepa/ under "Policy and Guidance"].

Compliance Assurance and Record Keeping Requirements

Whenever hazardous wastes are generated or stored, they are subject to routine inspection, record keeping, and reporting requirements. The applicable Federal regulations are outlined in 40 CFR 264.15 and in the specific regulatory sections for each different type of unit.

Permit Considerations

The current RCRA permit status of a site and the unit where remediation wastes are managed may affect the subsequent need to obtain a permit or a permit modification for managing soil that is hazardous environmental restoration waste. Under RCRA corrective actions, a project manager can generate and store environmental restoration waste without obtaining a permit provided certain quantity limits and accumulation time restrictions are met. To generate and store environmental restoration wastes without a permit, the site can not store the wastes for more than 90 days. Small quantity generators, those who generate 100 - 1000 kg per month, may store wastes without a permit for up to 180 days provided the total quantity of waste onsite does not exceed 6,000 kg. EPA or the State may grant extensions to these accumulation restrictions on a case-by-case basis.

The exemption for 90-day accumulation is promulgated in 40 CFR 262.34 and associated preamble discussion is found at 51 FR 10168, March 24, 1986.

If the waste will be treated on site then the site will need to have a RCRA TSDF permit and comply with all the applicable requirements in 40 CFR parts 264 and 265 for the specified treatment type.

If the contaminated soil will be treated on site, the site will need a RCRA TSDF permit.

Under EPA's interpretation of CERCLA Section 121(e), project managers must only meet the substantive requirements of other laws and regulations for on-site actions. This removes the need to require permits as part of a response action. Substantive requirements such as inspections and use of proper containers still must be met.

Requirements During Treatment and Post-Treatment

The primary requirement associated with treatment of hazardous environmental restoration soil wastes are those of the RCRA LDRs. Until recently, project managers often relied on site-specific treatability variances under 40 CFR 268.44 to comply with LDRs. Recently, however, EPA promulgated the final Phase IV LDR rule for hazardous contaminated soil because it has long recognized that the LDR treatment standards for as-generated industrial hazardous waste were not always as appropriate for contaminated media. The Agency also recognized that the previous LDRs for such industrial hazardous wastes may be unachievable in hazardous contaminated soil or may be inappropriate for hazardous contaminated soil due to peculiarities associated with the soil matrix and the remediation context under which most contaminated soil is managed. In this new rulemaking, therefore, EPA promulgated specific standards for hazardous contaminated soil.

See 63 FR 28605, May 26, 1998, for the LDR treatment standards for contaminated soil.

Scope and Applicability

The contaminated soil LDR standards promulgated in the Phase IV rule apply to hazardous contaminated soil when it is generated and subsequently placed in a land disposal unit. The definition of soil includes clay, silt, sand, or gravel size particles, or a mixture of such materials with liquids, sludges, or solids which is inseparable by simple mechanical removal and is made up primarily of soil by volume. Small volumes of sludges and sediments may be treated to the new LDR standards to the extent that they fit the definition of soil; in other words, they must be in a mixture that is predominately soil (based on field inspection), and must be unable to be separated by simple mechanical removal processes. EPA emphasized in the rulemaking that three principles must be adhered to when LDRs apply to prohibited hazardous wastes, including contaminated soils.

Use of the new soil treatment standards will not be necessary at every Superfund site. **As was true prior to the Phase IV rule, hazardous contaminated soil that is not excavated for subsequent management (i.e., not generated) is still not subject to LDRs**. Also, consistent with current policy, soil managed within an area of contamination, even if it is excavated and replaced on the land within such an area, is still not subject to the LDRs.

LDRs also will not require treatment when the soil already meets the LDR treatment standards or, as outlined in Chapter 3, the soil does not contain a listed hazardous waste and is not hazardous due to a characteristic.

Basis for New Soil Treatment Standards.

The Phase IV rule establishes a new LDR treatability group, contaminated soils, and new LDR treatment standards specific to that group. Unlike LDR standards for industrial wastes, the new LDR treatment standards for soil are not based on the performance of Best Demonstrated Available Technologies (BDAT). Rather, EPA set standards that can be achieved using a variety of treatment technologies that achieve substantial reductions in concentration or mobility of hazardous constituents and that are generally used to treat soils.

New Soil LDR Standard.

The universal treatment standards are codified in 40 CFR 268.48.

Project managers managing contaminated soil continue to have the option of complying either with the existing treatment standards for industrial hazardous waste or the newly established soil treatment standards. When using the new standards, the regulation requires that constituents in hazardous contaminated soils must be treated to reduce the concentration of hazardous constituents by 90 percent for any one constituent, capped at 10 times the universal treatment standard. Under this standard, all hazardous contaminated soil, including soil contaminated by listed hazardous waste must be treated for each underlying hazardous constituent reasonably expected to be present when such constituents are initially found at concentrations greater than 10 times the universal treatment standard. In addition to treatment of all underlying hazardous constituents, soil exhibiting one or more of the characteristics for hazardous soil must also be treated to the point that it no longer exhibits the characteristic. In the case of soil that would be hazardous under the toxicity characteristic (TC) test, this treatment must be for the TC constituent and, in the case of ignitable, corrosive, or reactive soil, for the appropriate characteristic property.

Sampling and Evaluation Requirements for Treatment Activities.

Compliance with the soil treatment standards will be measured and enforced using grab samples. Compliance with the 90 percent reduction standard should generally be measured using total constituent concentrations. For hazardous constituents which have a treatment standard measured based on concentrations in a TCLP extract, compliance should be measured in leachate using the toxicity characteristic leaching procedure (TCLP).

Soil contaminated with a newly identified waste covered under an LDR prohibition extension does not need to be managed as a hazardous waste under RCRA Subtitle C. Until these dates expire, soil contaminated with the affected wastes can be land disposed without treatment; however, the disposal unit must meet the minimum technology requirements for that unit.

EPA's minimum technology requirements for hazardous waste landfills are codified in 40 CFR 264.301.

<u>*Closure of Waste Management Units*</u>

The primary requirements that project managers must meet following completion of treatment will be meeting the requirements associated with closing the unitss both that managed the waste during remediation and those that receive environmental restoration soils wastes for final disposal (in addition to any source areas where residual contamination may be left in place). Typically, the closure requirements of interest will be those for units such as tanks, impoundments, and landfills, although other types may be triggered depending on the nature of remediation activities.

EPA recently promulgated the post-closure rulemaking (63 FR 56710, October 22, 1998), which increases the flexibility of the authorities under which unit closure can occur. These requirements generally will not apply to remediation projects (because they address regulated units), but some of the aspects of the regulations may be relevant and appropriate. See "Standards Applicable to Owners and Operators of Closed and Closing Hazardous Waste Facilities: Post-Closure Permit Requirement and Closure Process," http://www.eh.doe.gov/oepa under "Policy and Guidance."

Generally, there are closure requirements specified in regulation for each type of unit. For example, the closure requirements for landfills are outlined in two sections of the regulations: 40 CFR Subpart G (general closure and post-closure requirements), and 40 CFR Subpart N (specific design and closure requirements for landfills). The regulations are typically a combination of performance objectives (e.g., ensure protection of human health through an effective monitoring program) and specific standards (e.g., composition and depth of final caps for land-based units).

In addition to the final disposition unit, project managers must ensure that any staging or storage areas and any areas used for treatment are closed in accordance with the applicable requirements. For example, temporary units and staging piles (two options for managing wastes during remediation discussed later in this Chapter) each have their own closure requirements specified in regulations.

5.5 Basic Management Requirements During Pre-Treatment, Treatment, and Post-Treatment Phases for Radioactive Soil Environmental Restoration Wastes

DOE Order 5820.2A, Radioactive Waste Management, has been replaced by DOE Order 435.1. The new Order was finalized on July 9, 1999. In addition to the Order, DOE has issued DOE M 435.1, which provides most of the technical requirements, and DOE G 435.1, which provides detailed technical guidance._ [http://www.explorer.doe.gov:1776/htmls/currentdir.html].

This section outlines the requirements that are triggered when managing radioactive wastes that are generated as part of environmental restoration projects.

A fundamental aspect of determining what management requirements are triggered is whether radioactive waste will be stored in existing facilities, or whether new facilities will be constructed and operated as part of an environmental restoration project. If existing facilities will be relied on, project managers can generally review the waste acceptance criteria for the facility to determine many of the specific requirements that will have to be met. If a new facility will be constructed, project managers will have to comply with the facility design and operating requirements established in DOE Order and Manual 435.1 (e.g., performance assessments, disposal authorization statements, composite analyses).

This section highlights the major requirements for storage, waste acceptance criteria, waste certification, treatment, packaging, and disposal of radioactive wastes in both scenarios. Project managers planning on constructing new facilities, however, should conduct a much more in-depth review of the DOE Manual 435.1 and its accompanying DOE G435.1, which provides nearly 1,000 pages of technical assistance.

Central to compliance with DOE O 435.1 and its accompanying Manual is ensuring that all facilities (and, therefore, generators of radioactive wastes) operate in compliance with a radioactive waste management basis. This basis is comprised of the following elements:

For waste generators (e.g., project managers shipping waste to a radioactive waste management facility), the waste certification program;

For waste treatment facilities, the waste acceptance criteria and waste certification program;

For waste storage facilities, the waste acceptance criteria and waste certification program; and

for waste disposal facilities, the performance assessment, composite analysis, disposal authorization statement, closure plan, waste acceptance criteria, and monitoring plan.

Each of these are described in more detail in the sections that follow.

5.5.1 Storage Requirements

Storage requirements for TRU waste and LLW are outlined in their respective chapters of the DOE M 435.1. The minimum storage requirements for LLW are:

- Wastes must be segregated based upon compatibility, safety criteria, and hazards;
- Wastes must be stored in a manner that protects the integrity of the waste package for the expected time of storage;
- Wastes with an identified disposal path can not be stored longer than a year prior to disposal, except for storage for decay purposes;
- Wastes without an identified path shall be characterized to ensure safe storage and to facilitate disposal;
- Characterization information shall be maintained;
- A process for low-level waste package inspection(s) and maintenance shall be developed and implemented;
- Low-level waste storage shall be managed to identify and segregate low-level waste from mixed low-level waste; and
- Staging of LLW for the purposes of accumulating appropriate quantities of waste material to facilitate transport, treatment and disposal must not occur for a period longer than 90 days unless all other requirements for LLW storage contained in Section IV(N) and I (13) of DOE M 435.1-1 are met.

Storage requirements for TRU and LLW are contained in Sections III and IV N of DOE M 435.1-1. [http://www.explorer.doe.gov:1776/htmls/currentdir.html].

If soil contaminated with transuranic (TRU) waste is generated during restoration activities, it must be segregated to avoid co-mingling of non-compatible waste streams and must be monitored as prescribed by the facility safety analysis to ensure that the wastes are maintained in a safe condition.

More information on TRU storage requirements is contained in Section III (N) of DOE Order M 435.1-1.

‘In addition, DOE M 435.1 III(H)(2) establishes that “TRU waste streams with no identified path to disposal shall be generated only in accordance with approved conditions which, at a minimum, shall address:

- Programmatic needs to generate the waste;

- Characteristics and issues preventing the disposal of the waste;
- Safe storage of the waste until disposal can be achieved; and
- Activities and plans for achieving final disposal of the waste.**"**

For project managers, this requirement may require consultation with managers of existing facilities to ensure that any TRU waste generated can be stored safely until final disposal options are available.

5.5.2 Waste Acceptance Criteria

Under DOE requirements, each treatment, storage, or disposal facility receiving waste is required to develop, maintain, and document WAC that will be used to evaluate waste received at its facility. Waste acceptance criteria are fundamental elements of the radioactive waste management basis established for all TRU and LLW management facilities and provide the physical, administrative and institutional controls needed to protect workers, members of the public and the environment from radioactive releases from such facilities. The WAC are established based on several facility-specific aspects: the facility design, facility safety analysis, facility authorization basis, governing regulations, and other pertinent information.
For waste TRU facilities, waste acceptance criteria includes the need to identify waste as defense or non-defense in origin to prevent co-mingling of potentially non-compatible waste streams. For LLW facilities, waste acceptance criteria address limits on the contact of waste material with water, and prohibitions against excessive liquid content in waste material, restrictions on the generation of explosive, reactive, or flammable gases and toxic vapors from LLW material that may harm waste handlers, members of the public or the environment and which may undermine the structural integrity of waste containers or the structural integrity of waste management facilities.

Waste acceptance criteria for TRU and LLW management facilities are discussed in Sections III and IV G of DOE Order M 435.1-1. [http://www.explorer.doe.gov:1776/htmls/currentdir.html]

The WAC are used by the receiving facility to evaluate waste received at its facility and should be used by the waste generating organization to prepare waste for shipment to the receiving facility.

Minimum waste acceptance criteria that facilities must incorporate to ensure the health and safety of personnel include:

Additional waste acceptance criteria governing LLW are mentioned in Section IV(G)(1)(d)(1-5) of DOE Order M 435.1-1.

- Waste must not be packaged in cardboard or fiberboard boxes, unless such boxes meet DOT requirements and contain stabilized waste with a minimum of void space;

- Wastes containing free liquid must be converted into a form that contains as little freestanding liquid as is reasonably achievable, but in no case shall the liquid exceed 1 percent of the waste volume when the waste is in a disposal container, or 0.5 percent of the waste volume processed to a stable form;

- Waste must not be readily capable of detonation or of explosive decomposition or reaction at normal pressures and temperatures, or of explosive reaction with water;

- Waste must not contain, or be capable of generating by radiolysis or biodegradation, quantities of toxic gases, vapors, or fumes harmful to the public or disposal facility personnel, or harmful to the long-term structural stability of the disposal site;

- Waste must not be pyrophoric; waste containing pyrophoric materials must be treated, prepared, and packaged to be non-flammable; and

- Low-level waste in gaseous form must be packaged such that the pressure does not exceed 1.5 atmospheres absolute at 20 degrees Celsius.

5.5.3 Waste Certification

Waste certification procedures for TRU waste and LLW provide appropriate assurance that authorized waste management officials have reviewed the characterization data for waste streams awaiting shipment and have determined that a receiving facility's acceptance criteria are being followed. As part of waste certification, calculations must be made to ensure that waste streams will be handled in such a way that packaged material will maintain its certification for further management after it has left the original shipment location.

Waste certification requirements for TRU and LLW are discussed in Sections III and IV (I, J&K) of DOE M 435.1-1. [http://www.explorer.doe.gov:1776/htmls/currentdir.html]

Waste certification is the responsibility of the generator or project manager of a environmental restoration project, in accordance with the requirements and procedures of the facility receiving the waste. Prior approval of waste stream receipt by an authorized official at such a receiving facility is also required before waste shipping. Authorized officials at receiving facilities must be able to trace the waste stream back to its source of generation or shipment, and verify that all appropriate characterization and certification information is contained in the documentation to accompany the waste shipment.

5.5.4 Treatment Requirements

Treatment requirements for TRU and LLW are discussed in Sections III and IV (D)(2), (M)(2) and (O) of DOE Order M 435.1-1. [http://www.explorer.doe.gov:1776/htmls/currentdir.html]

The treatment requirements for soil contaminated with radionuclides will primarily be driven by the waste acceptance criteria for the disposal facility, as mandated by the radioactive waste management basis for

TRU and LLW materials (discussed in Sections III and IV (D)(2) of DOE Order M 435.1-1, and in 5.1 of Chapter 5 of this *Guide*). Technical requirements for facility design and the direct treatment objectives established for TRU waste and LLW, however, also have a large impact on how environmental restoration wastes such as soils are treated. Technical considerations for the treatment of radioactively contaminated soils (as part of other radioactive materials that are managed) are contained in the waste treatment facility design requirements outlined in Sections III and IV (M)(2), that pertain to adequate waste confinement, ventilation of volatile gases and toxic vapors, decontamination capabilities for treatment facilities, and provisions for leak detection, prevention, and monitoring mechanisms.

For TRU, waste material must be treated as necessary to meet the waste acceptance criteria of the waste facility receiving the waste for storage or disposal. For LLW, treatment may be required to provide a more stable waste form and improve the disposal facilities' long-term performance goals.

5.5.5 Package and Transportation Requirements for Radioactive Wastes

Waste packaging and transportation requirements are found in Section IV (L) of DOE 435.1-1. [http://www.explorer.doe.gov:1776/htmls/currentdir.html]

Low-level waste (LLW) must be packaged in a manner that provides containment for the duration of the anticipated storage period and until disposal. When the LLW is packaged, the waste must be documented, marked, and labeled to identify the contents of the package and to facilitate reporting on the waste manifest (DOE M 435.1-1). As part of packaging requirements for LLW, vents and other aeration measures should be provided if the potential exists for explosion, flammability, or pressure buildup within containers due to excessive gas concentration.

LLW must be transported to treatment, storage, or disposal facilities on a schedule coordinated in advance with the facility receiving the waste, as part of waste transfer requirements contained in Section IV(K) of DOE Order M435.1-1. Prior to waste transfer, characterization and certification procedures must be undertaken to ensure that the waste acceptance criteria of the receiving facility are met and that the waste package (and its contents) will maintain their certification status after arrival. The subsequent number and volume of LLW shipments must then be minimized based on plans developed by the field as part of waste transportation requirements.

Information on general waste characterization, certification and transfer for TRU is contained in Section III (I, J, and K) of DOE Order M 435.1-1. Packaging and transport requirements are contained under Section III (L). [http://www.explorer.doe.gov:1776/htmls/currentdir.html]

Transuranic (TRU) waste must be shipped in compliance with site-specific requirements for on-site shipments and with Department of Transportation (DOT) requirements for off-site shipments. Prior to any shipments being released however, a waste transfer schedule must be authorized in advance by officials at the receiving facility that is based on waste characterization data, official certification and other information that may be necessary to track a particular waste stream.

Although off-site shipment of transuranic waste may be allowed in any of several shipping packages approved by the Nuclear Regulatory Commission and DOT, the only shipping container currently approved for shipment of transuranic waste to the Waste Isolation Pilot Project (WIPP) is the TRUPACT-II. The TRUPACT-II is only approved for contact-handled transuranic waste. Remote-handled transuranic waste must be shipped in an approved packaging system; the current plan for remote-handled transuranic waste shipment to WIPP is in the remote-handled-72B (RH-72B) cask/canister system. Other packaging systems may be approved, but the site will need to apply for package approval through 10 CFR Part 71, Subpart D.

5.5.6 Disposal Requirements

The basic requirements for use of the TRUPACT-II for transuranic waste are provided in the WIPP waste acceptance criteria document, DOE/WIPP-069, Rev. 5, 1996.

The disposal requirements specified in DOE M 435.1 are designed primarily for operators of these facilities and would apply as part of environmental restoration waste management where a remediation-waste disposal facility is built or operated. The DOE Manual specifies minimum requirements for facility design and operation, performance assessments, composite analyses, closure plan, and monitoring (in addition to obtaining a disposal authorization statement).

To the degree that CERCLA actions have equivalent substantive requirements, the requirements outlined in the DOE Order and Manual do not have to be separately met and demonstrated. As outlined in DOE M 435.1, I (F)(5),

> *Environmental restoration activities using the CERCLA process (in accordance with Executive Order 12580) may demonstrate compliance with the substantive elements of DOE O 435.1, Radioactive Waste Management, and this Manual (including the Performance Assessment and performance objectives, as well as the Composite Analysis) through the CERCLA process. However, compliance with all substantive requirements of DOE O 435.1 not met through the CERCLA process must be demonstrated. Environmental restoration activities which will result in the off-site management and disposal of radioactive waste must meet the applicable requirements of DOE O 435.1, Radioactive Waste Management, and this Manual for the management and disposal of those off-site wastes. Field elements performing environmental restoration activities*

involving development and management of radioactive waste disposal facilities under the CERCLA process shall

(a) Submit certification to the Deputy Assistant Secretary for Environmental Restoration that compliance with the substantive requirements of DOE O 435.1 have been met through the application of the CERCLA process; and

(b) Submit the decision document, such as the Record of Decision, or any other document that serves as the authorization to dispose, to the Deputy Assistant Secretary for Environmental Restoration to approve.

It is important to note that activities taken under RCRA corrective action do not have the same equivalency clause as part of the DOE Order.

The remainder of this section describes the major elements associated with the design of a new disposal facility.

Site Evaluation and Facility Design Requirements

The provisions most relevant to the management and disposal of radioactive soil wastes are contained in Sections IV (M)(1)(a)(2&3), which state that disposal facilities must not be located in flood plains, tectonically active areas, zones of water table changes, and in areas where contaminant migration pathways are unpredictable and erosion and surface runoff cannot be controlled.

Site Evaluation and Facility Design requirements for LLW facilities are outlined in Section (M)(1) of DOE Order M 435.1-1. [http://www.explorer.doe.gov:1776/htmls/currentdir.html]

Performance Assessments

Performance assessments serve to evaluate whether the radioactive dose limits for particular exposure pathways have been achieved and for setting the point of compliance for the highest projected radioactive doses surrounding disposed waste material. If LLW is disposed in buried units that are located near surface soils, the performance assessment is a valuable instrument in determining whether near-surface soils have

become radioactively contaminated themselves, and if so, what levels of radioactivity would be allowable so as to avoid any adverse impacts on water sources, and what exposures potential human intruders would experience if entering the disposal facility after closure. All such calculations of allowable radioactive releases from LLW disposal

Performance Assessments for LLW disposal facilities are discussed in Section IV(P)(2&4) of DOE Order M 435.1-1.

facilities to the environment must demonstrate that any releases will be as low as reasonably achievable (ALARA).

Composite Analyses

LLW disposal facility performance assessments are complemented by composite analyses. Composite analyses achieve the following goals relative to waste disposal requirements: (1) They account for all additional sources of radioactive material (including media such as soils that are surrounding closed disposal units) at DOE sites that may interact adversely with a closed disposal facility and further increase risks to the public and environment (2) The results of composite analyses must be used to reduce the likelihood that any further remediation will be needed at a site after closure. Both performance assessments and composite analyses undertaken for LLW disposal facilities must be updated periodically to address gaps in data, and to evaluate changes that could affect the performance or structural integrity of the disposal facility.

For more information on composite analyses conducted for LLW disposal facilities, refer to Section IV(P)(3) of DOE Order 435.1-1. [http://www.explorer.doe.gov:1776/htmls/currentdir.html]

Closure Plan Requirements

LLW disposal facilities must develop closure plans. Preliminary closure plans are developed and submitted for review with disposal facility performance assessments and composite analyses, and must be updated upon issuance of the disposal authorization statement, and during the operational life of the facility. Such plans shall include the total expected inventory of wastes to be disposed at a facility over its operational life, and must have a description of the manner in which the facility will be closed so as to achieve long-term stability and reduce the need for active maintenance.

Closure plan requirements for LLW disposal facilities are contained in Section IV(Q) of DOE Order M 435.1-1.

Final closure plans developed for LLW facilities shall include the final inventory of waste in the disposal facility and designate institutional controls and measures that will be integrated into land use and stewardship programs that will ensure the long-term stability of the disposal facility following closure. The location and use of disposal facilities must be filed with local authorities in charge of land use and zoning.

Monitoring requirements

Preliminary monitoring plans must be prepared simultaneously with the performance assessment and composite analyses before the issuance of the disposal authorization statement and opening of the disposal facility. Updated monitoring plans are then issued one year after the approval and establishment of the disposal authorization statement and must include technical designs for measuring and evaluating releases, migration of

Monitoring plan requirements for LLW disposal facilities are discussed in Section IV (R)(3) of DOE Order M 435.1-1. [http://www.explorer.doe.gov:1776/htmls/currentdir.html]

radionuclides, subsidence of the disposal facility and any changes that may affect the long-term performance of the disposal facility. Updated monitoring plans should be able to detect trends in facility performance to allow application of any corrective action that may be necessary.

5.6 Basic Management Requirements During Pre-Treatment, Treatment, and Post-Treatment Phases for Mixed Waste

Environmental restoration soil wastes that are regulated as mixed wastes generally must meet the requirements of both the hazardous and radioactive waste requirements outlined in Sections 5.4 and 5.5. Mixed wastes must be managed in accordance with Sections III and IV (B)(1) of DOE Order M 435.1-1, and apply to TRU and LLW respectively.

Two areas in which unique considerations may be necessary for mixed wastes include testing and waste characterization requirements, and inspections. Waste characterization requirements are particularly important to consider, since these standards serve as guides for determining whether a particular waste type is acceptable for release, is in a form stable enough to ensure safe handling and transport and is traceable to its source of generation. In addition, waste characterization information is crucial for determining whether or not a potential receiving facility's performance objectives can be met, based on the characteristics and compatibility of substances in the waste stream that is to be sent.

Waste characterization requirements for TRU and LLW are contained in Sections III and IV (I) of DOE Order M 435.1-1.

Mixed wastes may pose health and safety concerns that do not exist with hazardous wastes and require DOE managers to meet ALARA (as low as reasonably achievable) disposal facility performance assessment requirements in order to conduct the waste management activity. For mixed waste containing LLW material, ALARA principles would need to demonstrate that an LLW disposal facility handling mixed waste would be capable of keeping releases of radionuclides within the waste material to the environment as low as reasonably achievable. To this end, DOE has published a draft Technical Standard that is designed to help project managers evaluate ALARA considerations.

5.7 Managing PCB- and Asbestos-Containing Soil Wastes

In some cases, environmental restoration soil wastes are contaminated (or contain co-located materials) that are contaminated with PCBs or asbestos. As outlined in Chapter 3, these types of contaminants are regulated at the Federal level by the Toxic Substances and Control Act (although some States classify these materials as hazardous or other types of regulated wastes).

The regulations for Federal PCB management are promulgated in 40 CFR Part 761, and specific requirements for remediation wastes are found at 40 CFR 761.61. Relevant guidance for PCB management include *Disposal Requirements for PCB Waste,* EH-231-056/1294, December 1994, and a recently promulgated update to the regulations found at 63 FR 35383, June 29, 1998.

5.7.1 Managing PCB-Contaminated Soils

PCB contaminated soils generated during environmental restoration actions are subject to the requirements of appropriate Federal or State regulations. In its 1998 regulation, EPA developed a self-implementing approach to the remediation of PCB wastes, and allowed the Regional Administrator to tailor these requirements where practicable. The main requirements of these regulations are found in Exhibit 5-8.

5.7.2 Managing Asbestos-Contaminated Soils

Asbestos-containing materials must be disposed of in accordance with the requirements in 40 CFR 61, Subpart M. Specific management and disposal requirements include:

See *Regulatory Requirements Affecting Disposal of Asbestos-Containing Material*, EH-413-062/1195 (November, 1995) for more information. [http://www.eh.doe.gov/oepa/ under "Policy and Guidance"].

- Control of air emissions during operations that manage asbestos-containing materials and use of emissions controls measures such as wetting asbestos-containing materials, turning friable asbestos-containing materials into a non-friable form, or other methods for control approved by EPA;
- Disposal of materials as soon as possible in a facility in accordance with the regulations;
- Maintaining records showing how materials were disposed; and
- Covering of the asbestos-containing materials during on-site operations at the end of each day.

Exhibit 5-8
Summary of PCB Requirements for
PCB Remediation Waste

Category	Requirements
Applicability.	The requirements may not be used to clean up surface, ground waters, or sediments. The requirements also are not binding on CERCLA and RCRA corrective action cleanups.
Notification and certification	40 CFR 761.61(a)(3) specifies requirements and processes for notifying and certifying cleanups under this section.

Category	Requirements
Bulk PCB remediation waste	Includes but not limited to non-liquid PCB remediation waste: soil, sediments, dredged materials, muds, sludges.
Bulk Remediation Waste: High occupancy areas	A cleanup level of 1 ppm is required. Where PCBs remain greater than 1 ppm, and less than 10 ppm, areas must be covered by a cap meeting the requirements of 40 CFR 761.61(a)(7)-(8).
Bulk Remediation Waste: Low occupancy areas	A cleanup level of 25 ppm is required. Where PCBs remain greater than 25 ppm and less than 50 ppm, the site must be secured by a fence and marked with a sign.
Non-porous surfaces	In high occupancy areas, surface cleanup standard is less than 10 mg/100cm2 of surface area. In low occupancy areas, the standard is less than 100 mg/100 cm2.
Porous surfaces	Same standards apply for high and low occupancy areas as exist for bulk remediation waste.
Liquids	Cleanup standards are set in 40 CFR 761.79(b)(1).

5.8 Compliance Options for Managing Soil Enviromental Restoration Wastes

Several compliance options exist that will drive the amount and type of treatment. These options for hazardous contaminated soil include:

- ARAR Waivers;
- Staging Piles;
- RAPs;
- Treatability Variances;
- Site-Specific, Risk-Based LDR Treatment Variances;
- Area of Contamination Policy;
- Corrective Action Management Units; and
- Temporary Units.

For radioactively contaminated soils, an option available is to determine that the soil is no longer radioactive waste. This option is discussed in Section 8.9 of Chapter 5 of this *Guide.*

ARAR waivers are only appropriate for CERCLA response actions and may be applicable for hazardous, radioactive, and mixed waste contaminated soils.

5.8.1 ARAR Waivers

Under CERCLA remedies, field managers can seek an exemption from clean-up standards by invoking an ARAR waiver. The restrictions on invoking waivers are codified in 40 CFR 300.430. ARAR waivers may be granted for one of the following reasons:

- Compliance will create a greater risk to human health or the environment;
- Technical impracticability;
- An alternative can result in an equivalent standard of performance;
- The state has inconsistently applied the requirement; or
- The action is an interim action.

5.8.2 Staging Piles

Staging piles allow Remedial Project Managers (RPMs) to use short-term storage of hazardous wastes under circumstances that are protective of human health and the environment without the extensive set of prescriptive standards that may be required for units in long-term use, such as liner requirements and meeting LDR treatment standards. The regulation establishes that staging piles can accept all types of solid, non-flowing (non-liquid) remediation waste. Staging piles are also addressed under Section IV (N)(7) of DOE Order M 435.1-1, as part of requirements governing interim storage of LLW. Under these standards, LLW such as radioactively contaminated soil may be staged for the purposes of accumulating sufficient quantities of waste to allow for easier transport, treatment or disposal. Any staging that occurs beyond 90 days, if involving LLW or mixed waste containing LLW constituents must meet Section IV (N)(4) Waste Characterization for Storage requirements.

Staging requirements are discussed under Section IV(N)(4) of DOE Order M 435.1-1.

Staging piles were created as part of the HWIR-Media rulemaking, 63 FR 65873, November 30, 1998.

5.8.3 Remedial Action Plans

Under the new HWIR-Media final rule, owner/operators can receive a RAP, rather than a traditional RCRA permit, for remediation waste management activities that take place at the site. RAPs are limited to authorizing the treatment, storage, or disposal of hazardous remediation wastes, and are generally limited to activities done in the area of contamination or areas in close proximity, unless managing the remediation waste off-site is more protective.

RAPs were created as part of the HWIR-Media rulemaking, 63 FR 65873, November 30, 1998.

Because of the CERCLA 121(e) permit exemption, under which EPA has concluded that the onsite portion of CERCLA cleanups do not need permits or need to meet other administrative requirements, the RAP may offer only limited advantages for Superfund RPMs.

5.8.4 Treatability Variances

Generators whose wastes cannot be treated to the new treatment standards may still petition EPA for a treatability variance. For EPA to grant a treatability variance, the petitioner must successfully demonstrate that the waste differs significantly from the wastes evaluated by EPA in developing the treatment standards. The petitioner must also demonstrate that the waste cannot be treated to the level or by the method specified as the treatment standard, or that the existing level or method is inappropriate for the waste. In granting a variance, EPA will establish a new treatability group for that waste and set a new treatment standard.

See 40 CFR 268.44(h)(4), promulgated May 26, 1998 and associated preamble at 63 FR 28606-28608. Regulations governing site-specific LDR treatment variances are at 40 CFR 268.44(h), August 17, 1988. Also refer to the memo, *Use of Site-Specific Land Disposal Restriction Treatability Variances Under 40 CFR 268.44(h) During Cleanups*.

5.8.5 Site-Specific, Risk-Based LDR Treatment Variance

Under 40 CFR 268.44(h)(3), variances from otherwise applicable LDR treatment standards may be approved if it is determined that compliance with the treatment standards would result in treatment beyond the point at which short- and long-term threats to human health and the environment are minimized. This allows a site-specific, risk-based determination to supersede the technology-based LDR treatment standards under certain circumstances. Alternative land disposal restriction treatment standards established through site-specific, risk-based minimize threat variance should be within the range of values the EPA generally finds acceptable for risk-based cleanup levels.

5.8.6 Area of Contamination Policy

In what is typically referred to as the area of contamination (AOC) policy, EPA interprets RCRA to allow certain discrete areas of generally dispersed contamination to be considered RCRA units (usually landfills). Because an AOC is equated to a RCRA land-based unit, consolidation and in-situ treatment of hazardous waste within the AOC do not create a new point of hazardous waste generation for the purposes of RCRA. This interpretation allows wastes to be consolidated or treated in-situ within an AOC without triggering land disposal restrictions or minimum technology requirements. The AOC interpretation may be applied to any hazardous remediation waste (including non-media wastes) that is in or on the land. [Note that the AOC policy only covers consolidation and other in-situ waste management techniques carried out within an AOC].

See 55 FR 8758-8760, March 8, 1990 and *Use of the Area of Contamination Concept During RCRA Cleanups* (EPA Memo, March 13, 1996).

5.8.7 Corrective Action Management Units

The corrective action management unit rule, 58 FR 8658, February 16, 1993, created a new type of RCRA unit–a Corrective Action

See *Corrective Action Management Units and Temporary Units*, EH-2131-043/0394 (March 1994), http://www.eh.doe.gov/oepa under "Policy & Guidance."

Management Unit or CAMU–specifically intended for treatment, storage, and disposal of hazardous remediation waste. To obtain a CAMU, a project manager must demonstrate its advantages based on seven decision factors:

1. The designation will help implement a reliable, effective, protective, and cost-effective remedy;

2. Waste management activities associated with the CAMU will not create unacceptable risks to humans or the environment;

3. In order to manage remediation wastes, the CAMU may include uncontaminated facility areas only if doing so is more protective than managing such waste at contaminated facility areas;

4. Wastes remaining after CAMU closure will be managed or contained to minimize future releases;

5. The designation will expedite the timing of remedial activity implementation when appropriate and practicable;

6. The designation will allow the appropriate use of treatment technologies to enhance remedial action by reducing the toxicity, mobility, or volume of wastes that remain after CAMU closure; and

7. The designation will minimize the facility's land area upon which wastes will remain after CAMU closure.

Several DOE sites have used CAMUs effectively as part of remediation plans, including Sandia National Laboratory in Albuquerque and Fernald in Ohio.

5.8.8 Temporary Units (TUs)

See *Corrective Action Management Units and Temporary Units*, EH-2131-043/0394 (March 1994) for more information.

Temporary units, like corrective action management units, are RCRA units established specifically for management of hazardous remediation waste. The regulations for temporary units (TUs) were promulgated at the same time as the regulations for corrective action management units. The TU regulations established non-land based units for treatment and storage of hazardous remediation waste. Under the TU regulations, EPA and authorized states may modify existing Minimum Technology Requirements (MTR) design, operating and closure standards for temporary tank and container units used to treat and store hazardous remediation waste. Temporary units may operate for one year, with an opportunity for a one year extension.

5.8.9 Determine Soil is No Longer Radioactive Waste

Soil that is contaminated with a small amount of radioactivity may qualify to be managed as non-radioactive waste. To be managed as non-radioactive waste, the radioactivity level in the waste must be equivalent to background levels or be determined to be nondetectable using "reasonable methods." The criteria for determining if a waste needs to be managed as radioactive waste are:

- The waste must meet DOE Order 5400.5 requirements;
- Releases of the material must not cause a maximum individual dose in excess of one millirem per year or a collective dose of more than 10 person-rems per year;
- A procedure must exist to maintain records consistent with DOE 5400.5 requirements; and
- ALARA process requirements must be achieved.

In addition, a soil that is contaminated with small amounts of radioactivity may be managed as non-radioactive if it can also be determined that the contaminants will not be managed in a LLW management facility, and are by-product or naturally occurring radioactive materials.

DOE Order O 435.1, Section 3(d) establishes exemptions for byproduct and naturally occurring radioactive material to be managed as "non-radioactive," provided it is not managed in a LLW facility.

Byproduct material is defined in DOE M 435.1-1, Appendix 2 as: (1) any radioactive material (except special nuclear material) yielded in or otherwise made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material, and (2) The tailings or wastes produced by the extraction or concentration of uranium or thorium from any ore processed primarily for its source mineral content. [Source: *Atomic Energy Act* of 1954, as amended, section 11(e)].

Detailed guidance on releasing radioactive contaminated waste from management for its radioactive content can be found in *Release of Hazardous Waste Containing Residual Radioactive Material Implementation Guide,* DOE G 435.1-2.

the environment is derived from the Atomic Energy Act as implemented through DOE directives (e.g., DOE Order and Manual 435.1-1, *Radioactive Waste Management Manual*, and DOE Order 5400.5, *Radiation Protection of the Public and the Environment*). DOE Order 435.1 and manual may be accessed at: http://www.explorer.doe.gov:1776/htmls/currentdir.html.

4.2 Summary of Ground Water Management Technologies

Exhibits 4-2 and 4-3 briefly describes some of the more common treatment technologies for hazardous and radioactively contaminated ground water and any resulting waste residuals. The purpose of the tables is to identify the likely types of environmental restoration waste streams that could require characterization and subsequent management if the approach is selected (and not to evaluate the feasibility of any single technology option).

Additional information on management technologies is available from many EPA Guides available through the Technology Innovation Office. Examples include *Technology Screening Guide For Radioactively Contaminated Sites*.

4.3 Basic Management Requirements During Pre-Treatment, Treatment, and Post Treatment Phases for <u>Hazardous Waste</u>

The waste handling and storage requirements for ground water that is managed as <u>hazardous waste</u> differ significantly depending on the ground water management approach selected. This section discusses the relevant planning considerations during initial waste handling activities as the ground water is generated, and requirements applicable during and after treatment (including management of any residuals) for monitored natural attenuation, active in situ, and ex-situ approaches.

Regardless of the management approach selected, contaminated ground water will always require some degree of monitoring -- either to ensure technology performance or to determine if it meets other regulatory requirements. Ground-water monitoring requirements are specified in several Federal regulations and policies, and depend on the statute under which remediation is occurring, the site-specific conditions for which monitoring must occur, and the type of remedial action selected (and, therefore, the purposes of the monitoring). Exhibit 4-4, shown on page 4-11 of this *Guide*, summarizes ground-water monitoring requirements for all management types and discusses when these requirements typically apply.

Exhibit 4-2
Typical Ground Water Treatments for Hazardous Wastes and Resulting Residuals

Treatment	Brief Technology Description	Ground Water Wastes Generated	Residual Wastes Generated	Follow-On Activities
IN-SITU REMEDIATION OPTIONS				
Bioremediation	Subsurface microorganisms biodegrade hydrocarbons by ingesting the contaminants and converting them to innocuous mineral end products.	Ground water is not extracted.	Residuals generally do not require further treatment or management.	Ground-water compliance monitoring.
Soil Vapor Extraction	Air is used to flush out volatile organic contaminants (including non-aqueous phase liquids, NAPLs) from ground water. The contaminants are transferred to the air and transported to the surface.	Ground water is not extracted.	The air discharge may require capture and treatment to comply with air emission requirements (40 CFR 61 and 63)(40 CFR 264 and 265).	Ground-water compliance monitoring. Air emission treatment.
Bioventing	Enhances aerobic biodegradation of petroleum hydrocarbons and chlorinated solvents by supplying oxygen to soil microbes. Contaminants are converted to innocuous products or transferred to the air.	Ground water is not extracted.	Capture and treatment of emissions may be required to comply with air standards (40 CFR 61 and 63)(40 CFR 264 and 265).	Ground-water compliance monitoring. Filter disposal.
EX-SITU REMEDIATION OPTIONS				
Air Stripping	Uses volatilization to transfer volatile organic contaminants from the ground water to air.	Treated ground water is generated. Volumes may be significant.	Air stream may need filtration or treatment. Possible secondary treatment of effluent required.	Disposal of water. Filter disposal. Ground-water compliance monitoring.

Treatment	Brief Technology Description	Ground Water Wastes Generated	Residual Wastes Generated	Follow-On Activities
Granular Activated Carbon (GAC)	Physically separates contaminants from ground water by adsorption onto activated carbon. Applicable to a wide variety of contaminants and generally used in conjunction with other treatments.	Extracted ground water is generated and must be managed in accord with requirements triggered by the selected disposal option	The carbon filter can be reactivated, regenerated, or disposed. If disposed the carbon must be managed as a hazardous waste if it exhibits a characteristic of or "contains" a hazardous waste.	Disposal of water. Filter disposal. Ground-water compliance monitoring.
Chemical Oxidation	Uses oxidizing processes to destroy or remove contaminants from ground water.	Extracted ground water is generated and must be managed in accord with requirements triggered by the selected disposal option.	Oxidation is not always complete or intermediate byproducts may require secondary treatment such as GAC.	Disposal of water. Ground-water compliance monitoring.
Aerobic Biological Reactors	Aerobic biological reactors use microorganisms to degrade organic contaminants	Extracted ground water is generated and must be managed in accord with requirements triggered by the selected disposal option.	A sludge is produced that may have concentrated metals or recalcitrant organic compounds. The sludge may need to be managed as a hazardous waste	Disposal of water. Disposal of sludge as a hazardous waste. Ground-water compliance monitoring.
Chemical Precipitation	Chemically converts dissolved metal and/or other inorganic ions into an insoluble or less soluble precipitate.	Extracted ground water is generated and must be managed in accord with requirements triggered by the selected disposal option.	The contaminants are removed by clarification or filtration and the resulting residue may require treatment prior to disposal.	Disposal of water. Disposal of residue. Ground-water compliance monitoring.

Treatment	Brief Technology Description	Ground Water Wastes Generated	Residual Wastes Generated	Follow-On Activities
Ion Exchange/Adsorption	Removes metals from contaminated ground water through a granular solid that exchanges sorbed ions for the dissolved contaminants.	Extracted ground water is generated and must be managed in accord with requirements triggered by the selected disposal option.	When the ion exchange is filled, it can be regenerated through backflushing. The contaminants will then be concentrated in the backflush, which will need to be treated to remove the metals or managed as a hazardous waste if it exhibits a characteristic of or "contains" a hazardous waste.	Disposal of water. Ground-water compliance monitoring.
Electrochemical Methods	Metals are recovered from aqueous solutions by applying an electrical current to two immersed electrodes.	Extracted ground water is generated and must be managed in accord with requirements triggered by the selected disposal option.	Precipitates will form a sludge that must be treated and/or disposed.	Disposal of water. Disposal of sludge as a hazardous waste. Ground-water compliance monitoring.

Exhibit 4-3
Typical Ground Water Treatments for Radioactive Wastes and Resulting Residuals

Treatment	Brief Technology Description	Ground Water Waste Generated	Residual Waste Generated	Follow-On Activities
Membrane Filtration	Uses a semipermeable membrane to separate dissolved radionuclides or solid radionuclide from the ground water itself. Membrane filtration has been demonstrated to be effective in treating uranium, radium, and plutonium in ground water.	Extracted ground water is generated and must be managed in accord with requirements triggered by the selected disposal option.	Residual sludge and filter cake require further handling, treatment, and/or disposal.	Disposal of sludge and filter cake. Ongoing monitoring and maintenance of the treatment system is required to ensure long-term effectiveness.
Carbon Adsorption	Pumps ground water through a series of vessels containing activated carbon, to which dissolved contaminants adsorb. When the concentration of contaminants in the effluent exceeds a certain level, the carbon can be regenerated in place; removed and regenerated at an off-site facility; or removed and disposed of. Carbon adsorption has been demonstrated to be effective in treating uranium, radon, and cobalt in ground water.	Extracted ground water is generated and must be managed in accord with requirements triggered by the selected disposal option.	Residual carbon adsorption unit requires further handling, treatment, and/or disposal.	Disposal of carbon adsorption unit. If disposed of, spent carbon may have to be managed as a hazardous waste. Ongoing monitoring and maintenance of the treatment system is required to ensure long-term effectiveness.

Treatment	Brief Technology Description	Ground Water Waste Generated	Residual Waste Generated	Follow-On Activities
Aeration	Injects air into the ground water, forming bubbles that rise and carry trapped and dissolved contaminants to the water surface. Aeration has been demonstrated to be effective in treating radon in ground water.	Extracted ground water is generated and must be managed in accord with requirements triggered by the selected disposal option.	Residual waste includes gas emissions, which must comply with Clean Air Act requirements.	An air treatment system may be required to address radon gas emissions. Ongoing monitoring and maintenance of the treatment system is required to ensure long-term effectiveness. Aeration is often a pretreatment for other remediation technologies, such as air stripping, and can be followed by treatments such as flocculation, sedimentation, and/or filtration.
Ion Exchange	Separates and replaces radionuclides in a waste stream with relatively harmless ions from a synthetic resin or natural zeolite (for strontium and cesium), thereby producing a clean stream. Ion exchange has been identified as the Best Available Technology (BAT) for the removal of uranium, radium-226, and radium-228; and is a demonstrated technology for strontium.	Extracted ground water is generated and must be managed in accord with requirements triggered by the selected disposal option.	Both concentrated waste removed from the resin and spent resin itself must be treated, stored, or disposed.	Resins must be regenerated by exposing them to a concentrated solution of the original exchange ion, while zeolites are stored as solid waste. Backflush solution must be disposed of or stripped of its contaminants. Post-treatment of spent ion exchange media may be required to recover concentrated contaminants or management as a hazardous waste may be required. May require an off-gas treatment system

Treatment	Brief Technology Description	Ground Water Waste Generated	Residual Waste Generated	Follow-On Activities
Chemical Precipitation	Converts soluble radionuclides to an insoluble form, or precipitate, through a chemical reaction or through changing the solvent's composition to diminish solubility. Removes precipitate using a solids/liquid separation process. Chemical precipitation has been demonstrated to be effective in treating uranium in ground water.	Ground water extracted; treated effluent may require further treatment or disposal.	Process residuals such as precipitated solids and sludge require further treatment, storage, or disposal. Residual sludge may require treatment before disposal.	Ion exchange and membrane processes are sometimes used to polish the treated effluent, if lower concentration levels are required.

Exhibit 4-4 - Ground Water Monitoring Requirements

Regulation	Application
National Contingency Plan (NCP)	Monitoring requirements generally will be specified in the Record of Decision (ROD) and are described in more detail in the remedial design and implementation documents.
CERCLA [40 CFR 300.430(f)(4)(ii)]	If hazardous wastes remain in place, CERCLA requires the performance of a five-year review. Project managers will need to monitor during remedial actions to determine if remedial action objectives (RAOs) are met or to determine if a technical impracticability determination can be supported [40 CFR 300.430(a)(1)(iii)(F)]. The NCP does not specify specific time periods for monitoring, nor specific methods. These will be determined based on site conditions and the purposes of the monitoring.
RCRA Subtitle C Subpart F (40 CFR 264.100 (f))	The existing RCRA Subpart F regulations determine how ground water must be monitored during corrective action until standards have not been exceeded for a period of three years.
Interim Status Requirements (40 CFR 265)	The RCRA interim status subpart F requirements specify the ground-water monitoring requirements that must be met at this type of facility.
RCRA Subtitle C corrective action requirements (proposed at 55 Federal Register 30798, July 1990); withdrawn in 1999 and never finalized	RCRA corrective action policies do not specify a uniform time frame for demonstrating compliance. Rather, they leave the type and frequency of monitoring to the Regional Administrator to specify the appropriate time frame on a site-specific basis. Note: EPA has decided not to finalize the proposed Subpart S regulations, and is in the process of establishing new guidance to implement the corrective action program. This *Guide* reflects current Agency thinking, as it is available, about ground water monitoring and additional guidance is under development
DOE Order M 435.1 for Radioactive Wastes	For disposal facilities, a preliminary monitoring plan must be submitted to Headquarters. The monitoring program should include measuring and evaluating effluent releases, migration of radionuclides, disposal unit subsidence, and changes which may affect long-term performance. It should also be capable of detecting trends in performance that would affect meeting performance objectives. All low-level waste facilities must meet the requirements set out in M 435.1 IV.R, which require monitoring for temperature, pressure (for closed systems), radioactivity in ventilation exhaust and liquid effluent streams, and flammable or explosive mixture of gases.

For additional information on monitoring requirements see *Federal Environmental Monitoring Handbook* available on the DOE OEPA homepage at: [http://www.eh.doe.gov/oepa/ under "Policy and Guidance"].

EPA also recently released draft guidance on conducting 5-year reviews as part of CERCLA actions that result in wastes left in place.

DOE Order M 435.1-1 establishes requirements for TRU and LLW disposal facility monitoring plans conducted under III(Q)(1-3) and IV(R)(1-3), respectively.

4.3.1 Monitored Natural Attenuation - Hazardous Ground Water

Natural attenuation typically does not generate environmental restoration waste or treatment residuals. Detailed information about use of natural attenuation can be found in OSWER directive, *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites*, April 21, 1999, (9200.4-17P).

Monitored natural attenuation (MNA) refers to reliance on natural attenuation processes, including a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. In recent years, this approach has received extensive attention as a feasible remediation approach. Natural attenuation is often used as a remediation strategy at sites where data indicate that natural processes will reduce contaminants in ground water to levels protective of human health and the environment. Because managing the contaminated ground water by natural attenuation is an in-situ approach and treatment method, no environmental restoration wastes or residuals are typically generated that require management. (However, in some cases, natural attenuation may result in transformation products (e.g., vinyl chloride from TCE degradation) that pose more risk to human health and the environment than the original chemical being treated).

Plume monitoring requirements under a natural attenuation approach can be extensive.

Although managing contaminated ground water through monitored natural attenuation generally does not create waste handling issues, this remediation approach often requires a relatively long time for completion of the remedy and may involve extensive long-term monitoring to ensure compliance with the cleanup standards. According to EPA, MNA should be used very cautiously as the sole remedy at contaminated sites. Therefore, consideration of monitored natural attenuation may also lead to evaluating alternative in- or ex-situ approaches as contingency plans if performance requirements are not met. Planning for handing of environmental restoration wastes may need to occur as a contingency when natural attenuation approaches are selected.

4.3.2 Active In-Situ Management - Hazardous Ground Water

Air emissions may be generated that will be subject to the Clean Air Act or State laws. Emissions of volatile organic contaminants generated during RCRA corrective action and CERCLA response actions, however, are exempt from the requirements in RCRA Subpart CC under certain circumstances, as specified in 40 CFR 264.1080(b)(5), specifically when such wastes are placed in tanks or containers solely for on-site treatment as a result of implementing remediation actions.

There generally are not waste handling requirements for contaminated ground water managed in-situ because this type of remedy does not generate water. However, in-situ treatments that extract organic contaminants as vapors do generate air emissions that are subject to the Clean Air Act National Ambient Air Quality Standard restrictions or National Emission Standards for Hazardous Air Pollutants. In addition, when residuals are extracted and captured through filters or other equipment, the filters may become regulated themselves as hazardous wastes. Specifically, as a result of the concentration of certain contaminants in a filter, the filter may exhibit a characteristic of a hazardous waste, or may remain a listed hazardous waste through the derived from rule [40 CFR 261.3(c)(2)(I)].

Exhibit 4-5 summarizes the standards that may apply to residuals and debris generated during use of active in-situ management options.

Exhibit 4-5
Summary of Potential Standards for Hazardous Waste Residuals Generated During In-Situ Management Actions

Type of In-Situ Residual	Potentially Applicable Regulatory Standard	Key Considerations When Complying with Standard
Organic Vapors	Air Emissions requirements under NESHAPs or under State air programs, or site permits to the degree that remediation sources are included. Short-term risk remedy selection criterion under CERCLA and RCRA corrective action may require evaluation to determine if controls are warranted.	1. Characterize emissions to determine volume and nature to determine if NESHAPs or other requirements apply, or if control technologies are needed. 2. Evaluation of risk during the remedial response may be required for remediation decision documents.
Spent Carbon Filters	RCRA LDRs (40 CFR 268) may apply depending on the materials captured in the filters. Either the filters may become listed hazardous waste through the derived from rule, or exhibit a characteristic of a hazardous waste.	Filters may be recyclable by a permitted entity. Opportunities often exist to integrate remediation management needs equipment acquisition associated with existing on-site monitoring programs.
Other filters or equipment used during in-situ extraction	Contact with hazardous wastes may cause equipment to become hazardous waste (e.g., debris).	Careful consideration of decontamination methods may be necessary to minimize further regulatory problems.

Materials not hazardous during one phase of handling may become subject to hazardous waste requirements during the treatment process. This necessitates that project managers consider additional characterization of waste each time contaminants are transferred from one medium or waste management system to another.

4.3.3 Ex-Situ Management - Hazardous Ground Water

Ground water that is managed ex-situ is subject to varying storage and handling requirements depending upon several factors. These factors include the 1) degree and level of contamination, 2) the quantity of ground-water environmental restoration waste generated, 3) the site's existing RCRA permit status, and 4) whether the ground water will be treated on site or off site.

Requirements During Initial Waste Handling Activities

In many cases, ground water is extracted and sent directly to a treatment system without any temporary staging or storage in a separate unit. This direct transport to treatment units eliminates many requirements typically associated with storage of hazardous wastes.

In other cases, direct treatment of extracted ground water may not be possible and the contaminated ground water is stored, resulting in certain regulatory requirements needing to be met (e.g., RCRA storage requirements for hazardous waste). This is particularly true during investigations when sampling of extracted ground water may be required before a waste management option can be used. Activities that may occur during pre-treatment of extracted ground water include:

- Transport (e.g., via pipe, truck);
- Storage of ground water extracted from wells as a part of sample collection activities (e.g., in tanks, containers); and
- Compliance assurance and record keeping and other similar requirements.

Transport Requirements

If environmental restoration waste that must be managed as a hazardous waste is being transported to an off-site treatment facility, the project manager must comply with the manifest requirements of Federal generator requirements found at 40 CFR 262 (or an equivalent State program), which typically include:

Wastes transported off site are subject to both RCRA and DOT regulations. Wastes transported onsite are subject to restrictions outlined in the site permit and site procedures. In all cases, corresponding State regulations may apply.

- Identification of the hazardous waste (40 CFR 262.11);
- Identifying the Treatment, Storage, and Disposal (TSD) facility, transportation mode, and company handling the waste (40 CFR 262.12);
- Properly packaging the waste (40 CFR 262.30);
- Abiding by labeling, marking, and placarding requirements (40 CFR 262.30 -262.33); and
- Completing and signing the manifest (40 CFR 262.20 -262.23).

Hazardous wastes that are forbidden from off-site transfer are identified in 49 CFR 172.101.

The Federal requirements for the transporter of the waste are identified in 40 CFR 263. In developing these regulations, EPA adopted most of the Department of Transportation's requirements for transporting hazardous waste (49 CFR 171 - 179), although a transporter should also refer directly to the DOT regulations to ensure they are in compliance.

Storage Requirements

Sites that are storing contaminated ground water that is hazardous waste must label the waste tanks or containers storing the water as hazardous, and comply with the regulations for tank systems (Subpart J of 40 CFR Parts 264 and 265) or container systems (Subpart I of 40 CFR Parts 264 and 265) while the waste is being stored onsite.

Waste accumulation and storage requirements change if the site manages any wastes generated in a temporary unit (TU) or obtains a remediation action plan (RAP) under the new HWIR-Media rule (63 FR 65873, November 30, 1998) . The streamlining available from TUs and a RAP in managing contaminated ground water is discussed in part 4.6.

If ground water containing hazardous waste will only be transported to an on-site treatment facility, the RCRA transporter requirements are not triggered, but on-site transport restrictions that may be included in the RCRA permit, order, compliance agreement, or operating procedure may have to be met.

Compliance Assurance and Record Keeping

Whenever hazardous wastes are generated or stored, they are subject to routine inspection, record keeping, and reporting requirements. These are outlined in 40 CFR 262 or the corresponding State regulations. If the action is taken under CERCLA and these requirements are ARARs, than the compliance assurance and record keeping requirements need to be met.

Permit Considerations

The current RCRA permit status of a site where remediation is occurring will often affect the subsequent need to obtain a permit or a permit modification for managing hazardous ground water when it is an environmental restoration waste. Under RCRA, a project manager can generate and store environmental restoration waste without obtaining a permit provided certain quantity limits and accumulation time restrictions are met. To generate and store environmental restoration wastes without a permit, the site can not store the wastes in tanks, containers, drip pads, or containment buildings for more than 90 days. Small quantity generators, those who generate 100 - 1000 kg per month, may store wastes without a permit for up to 180 days provided the total quantity of waste onsite does not exceed 6,000 kg. EPA or the State may grant extensions to these accumulation restrictions on a case-by-case basis. Accumulation units must meet applicable design, operating, closure, and post-closure standards.

If the waste will be treated onsite then the site will need to comply with a RCRA corrective action order, have a RCRA TSDF permit or interim status, comply with all the applicable sets of requirements in 40 CFR parts 264 and 265 for the specified treatment, or use one of the compliance options discussed in Section 4.6. Alternatively, the unit may be subject to RCRA's permit-by-rule provisions (40 CFR 270.60), and will only have to be in compliance with these requirements to be considered permitted. The permit-by-rule provisions apply to the following types of facilities:

If the contaminated ground water will be treated on site, the facility at the site will need a RCRA TSDF permit.

- Underground injection wells with permits under the Safe Drinking Water Act (SDWA);
- POTWs with NPDES permits; and
- Ocean disposal barges or vessels with ocean dumping permits.

Under CERCLA 121(e), project managers must only meet the substantive requirements of other laws and regulations for on-site actions. This removes the need to require permits as part of a response action. Substantive requirements such as inspections and use of proper containers still must be met.

The exemption for ninety-day accumulations is found in regulations at 40 CFR 262.34; associated preamble discussion is at 51 FR 10168 (March 24, 1986).

<u>Requirements During and After Remediation Activities</u>

During treatment, the requirements for managing hazardous ground water fall into two types of requirements:

- Ensuring that any regulatory requirements established as applicable during the pre-treatment phase (e.g., related to transport, storage, or staging of wastes) continue to be met, particularly during any periods where treatment systems may be idle due to logistical problems or mechanical failures; and

- Evaluating the regulatory status of treated ground water and any residuals generated to ensure that post-treatment plans for waste handling are still appropriate.

As remediation occurs and wastes are generated, issues for units treating ex-situ ground-water include proper handling of the residual contaminants separated from the water and management of the treated ground water, as outlined below. In addition, units in which waste management is no longer occurring will be subject to closure and post-closure care requirements.

Managing Residuals Generated During Treatment

Residuals from ground-water treatment typically have to be managed as hazardous waste because the RCRA derived-from rule make them listed wastes or the contaminants present in the residuals result in the waste exhibiting a hazardous characteristic. Examples of these residuals include carbon filters from granular activated carbon (GAC), precipitates, and sludges from treatment operations (See Exhibit 4-5).

Options for Managing Treated Water

Treated ground water typically is reinjected into an aquifer, discharged through a National Pollutant Discharge Elimination System (NPDES) permit, sent to a Publicly Owned Treatment Works (POTW) or Federally Owned Treatment Works (FOTW), or treated in an on-site wastewater treatment plant. The selection of a management option will depend on regulatory considerations, characteristics of the treated ground water, availability of a management option, and local considerations about the use of the treated ground water.

More information regarding strategy and treatment of ground water can be found in *Presumptive Response Strategy and Ex-Situ Treatment Technologies for Contaminated Ground Water at CERCLA Sites*, EPA OSWER Directive 9283.1-12, October 1996.

Requirements for each available option are described below.

1. *Reinjection*. If the ground water no longer exhibits a characteristic of a hazardous waste or no longer "contains" a listed waste, then direct reinjection of the ground water may be permitted in accordance with a State or local reinjection program. If the ground water was contaminated with a listed hazardous waste (even in low concentrations) then it cannot be reinjected unless certain requirements are met (e.g., the well can legally accept hazardous waste under a underground injection program or other legal mechanism). If the ground water was extracted during a RCRA corrective action or is managed off site under a CERCLA response action, then the ground water may have to undergo a "contained out" evaluation or formal delisting procedure before it can be reinjected.

Extracted ground water can be:

1. reinjected;
2. discharged through a NPDES permit;
3. sent to a POTW or FOTW; or
4. treated at an onsite wastewater treatment plant.

Delisting (obtaining a regulatory determination that a waste is no longer listed wastes because of the concentrations of the contaminants present) may be an option to consider for ground water with low concentrations of listed wastes, as evaluated and determined by the EPA or State Administrator. "Low concentrations" are evaluated by comparing the concentration of constituents present to the leachate concentration as determined using the TCLP, or health-based levels such as Maximum Contaminant Levels (MCLs). Ground water with higher concentrations may also be delisted based on fate-and-transport modeling results. If the extracted ground water was contaminated with a listed waste, removed during a CERCLA response action, and managed on site, the field manager will not need to undergo the delisting petition and rule-making process. Compliance with the substantive delisting requirements should be documented in the Record of Decision, Statement of Basis, or application for a permit modification.

2. *National Pollutant Discharge Elimination System*. In some cases, treated ground water can be directly discharged to surface waters under a NPDES permit. Extracted ground water discharged through a NPDES permit will also be subject to state and federal water quality criteria. If the extracted ground water is contaminated with radioactive mixed waste rather than hazardous waste, it cannot be discharged through a NPDES permit without first applying the BAT for treating the radioactive component in addition to meeting any requirements for hazardous constituents that are present..

Federal regulations governing discharges through a NPDES permit are codified in 40 CFR 122-125, 129.

3. Publicly Owned Treatment Works and Federally Owned Treatment Works. In some cases extracted ground water can be discharged to a POTW. Some discharges are directly prohibited or will require special approval. Discharges that are explicitly prohibited from all POTWs include:

Federal POTW pre-treatment requirements are codified in 40 CFR 403.

- Pollutants that create a fire or explosion hazard;
- Pollutants that are corrosive;
- Solid or viscous pollutants;
- Pollutants that will cause " interference" with the POTW such as oxygen demanding pollutants;
- Heat in amounts that will inhibit biological activity;
- Petroleum oils, nonbiodegradable cutting oil, or mineral oil products; and
- Pollutants that will cause toxic gases, vapors or fumes.

If the ground water originated from a CERCLA response action, the field manager will need to confer with the Regional Offsite manager to ensure that the POTW meets EPA's criteria for an "acceptable" offsite facility. Extracted ground water originating from a RCRA corrective action is not subject to the off-site rule (citation). The field manager will need to refer to the requirements specific to the POTW to determine if any wastewater acceptance restrictions or pretreatment requirements exist.

For more information on FOTWs, please refer to *Federal Facility Compliance Act Implications for RCRA Corrective Action*, EH-231-015/0994, September 1994, [http://www.eh.doe.gov/oepa under "Policy and Guidance"].

The Federal Facilities Compliance Act modified RCRA Subtitle C to ensure similar treatment for both municipal POTWs and FOTWs. The modified sections provide that FOTWs are exempted from RCRA regulations if one of the following criteria are met:

- Materials must be subject to a pretreatment standard under section 307 of the Clean Water Act (CWA);

- Materials not currently covered by a pretreatment standard must be in compliance with an EPA promulgated pretreatment standard that was applicable before October 6, 1999;

- Materials not covered under either of the above criteria are treated in accordance with applicable LDRs; or

- The generator is a conditionally exempt small quantity generator (CESQG).

DOE Order 5820.2A, the previous Radioactive Waste Management Order, has been canceled and replaced by DOE Order 435.1 and DOE Manual 435.1 as of July, 1999.

4. On-site Wastewater Treatment. To treat the extracted ground water on site, the site must have a RCRA treatment, storage, or disposal facility permit (or meet permit-by-rule requirements) and must handle the extracted ground water in accordance with the requirements for the permit, generally by complying with the facility's permit criteria and operating plans about what wastes can be accepted.

4.4 Basic Management Requirements During Pre-Treatment, Treatment, and Post-Treatment Phases for Radioactive Waste

This section outlines the requirements for extracted ground water that contains radioactive constituents and, therefore, that must be managed as a radioactive waste. The sections that follow describe the requirements for storage, treatment, and packaging of ground water transuranic and low level environmental restoration wastes**.** More details about the requirements for constructing facilities for disposing of residuals from the treatment of contaminated ground water are found in Chapter 5 of this *Guide***.**

DOE Manual 435.1 establishes that "environmental restoration activities using the CERCLA process...may demonstrate compliance with the substantive elements of DOE O 435.1...and this Manual...through the CERCLA process." In general, CERCLA actions will accomplish this by ensuring protection of human health and the environment and identifying the appropriate parts of the Manual that are appropriate to meet.

4.4.1 Storage Requirements for Radioactive Wastes

In general, extracted radioactively contaminated ground water is unlikely to be stored unless it is awaiting sampling and analysis results. This storage would commonly occur in tanks or drums. Whenever storage occurs, it must be done in accordance with site-specific operating procedures or site waste acceptance criteria for a storage facility or unit. DOE Order M 435.1-1 establishes general baseline storage requirements for all radioactive waste types in Section I (2)(F)(13). According to these requirements all radioactive waste must be stored in a manner that protects the public, workers, and the environment in accordance with a radioactive waste management basis, and that integrity of waste storage is maintained for the expected time of storage and does not compromise meeting the disposal performance objectives for protection of the public and environment when the waste is disposed. DOE Order M 435.1-1 also provides specific storage requirements for TRU and LLW.

The requirements for storage of TRU liquid wastes such as contaminated ground water are contained under the site facility design, storage and monitoring requirements of DOE Order M 435.1-1, Sections III M, N, and Q respectively:

Site facility design:

A radioactive waste management basis includes elements such as a waste certification program and waste acceptance criteria, and (for disposal facilities) the performance assessment, composite analysis, disposal authorization statement, closure plan, waste acceptance requirements, and monitoring plan.

- Engineering controls shall be incorporated in the design and engineering of TRU waste storage facilities to provide volume inventory data and to prevent spills, leaks, and overflows from tanks or confinement systems.

- Monitoring and/or leak detection capabilities shall be incorporated in the design and engineering of TRU waste storage facilities to provide rapid identification of failed confinement and/or other abnormal conditions.

Storage:

- TRU in storage should not be capable of detonation, explosive decomposition, reaction at anticipated pressures or temperatures, or explosive reaction with water.

- TRU shall be stored in a location and manner that protects the integrity of waste for the expected time of storage and minimizes worker exposure.

- If ground water contaminated with TRU is generated during remediation (e.g., in tanks), it must be stored in a segregated manner to avoid commingling of non-compatible waste streams, and must be monitored as prescribed by the facility safety analysis to ensure wastes are maintained in a safe condition.

DOE Order M 435.1-1 Sections III M, N and Q contain requirements for storage of TRU waste [http://www.explorer.doe.gov:1776/htmls/currentdir.html].

Monitoring:

- Parameters such as temperature, gaseous pressure (for closed systems), radioactivity in ventilation exhaust and liquid effluent streams and flammable or explosive mixtures of gases shall be monitored at TRU storage facilities to ensure that passive and active control systems have not failed.

- All TRU wastes in storage shall be monitored to ensure the wastes are being maintained in safe condition.

The requirements for storage of low-level liquid wastes such as contaminated ground water are in DOE Order M 435.1-1 Sections IV (L)(1)(a), IV (M) and IV (N). Requirements for LLW storage include:

Packaging:

DOE Order M 435.1-1 Sections IV (L)(1)(a), M and N contains requirements for the storage of LLW liquid waste. [http://www.explorer.doe.gov:1776/htmls/currentdir.html].

- LLW shall be packaged in a manner that provides containment and protection for the duration of the anticipated storage period and until final disposal is achieved or until the waste has been removed from the container.

Site evaluation and facility design:

- Engineering controls shall be incorporated in the design and engineering of LLW storage facilities to provide volume inventory data and to prevent spills, leaks, and overflows from tanks or confinement systems.

- Monitoring and/or leak detection capabilities shall be incorporated in the design and engineering of LLW treatment and storage facilities to provide rapid identification of failed confinement and/or other abnormal conditions.

Storage and Staging:

- Waste in storage shall not be readily capable of detonation, explosive decomposition, reaction at anticipated pressures and temperatures, or explosive reaction with water;

Interim storage of low-level waste awaiting treatment or disposal will be limited to 180 days unless approved by the field element manager.

- Wastes must be segregated based upon compatibility, safety criteria, and hazards;

- Wastes must be stored in a manner that protects the integrity of the waste package for the expected time of storage;

- Wastes with an identified disposal path cannot be stored longer than a year prior to disposal except for storage for decay purposes;

- Wastes without an identified path shall be characterized to ensure safe storage and to facilitate disposal;

- Characterization information shall be maintained;

- A process for low-level waste package inspection(s) and maintenance shall be developed and implemented to ensure that container integrity is not compromised;

- Low-level waste storage shall be managed to identify and segregate low-level waste from mixed low-level waste; and

- Staging, or interim storage of LLW for the purposes of accumulating sufficient waste quantities to facilitate transport, treatment and disposal, that occurs longer than 90 days shall meet the waste storage requirements of Section IV of DOE Order M 435.1-1.

4.4.2 Treatment Requirements for Radioactive Wastes

The treatment requirements for ground water contaminated with radionuclides will primarily be driven by the WAC of the treatment and/or disposal facility. Because the major disposal facilities for radioactive waste cannot accept liquid radioactive waste, the ground water generally must be treated to separate the radioactive constituents from the contaminated ground water. [Exhibit 4-3 provided a description of treatment technologies for radionuclides in ground water.]

Treated ground water will also need to comply with any RCRA requirements that are triggered by the presence of hazardous constituents prior to reinjection or disposal.

Following treatment, the separated treatment residuals, which generally are still radioactive wastes, can then either be disposed on site or sent to an on- or off-site facility. Similar to hazardous waste, the treated ground water can then be reinjected, discharged through a NPDES, or sent to a POTW or FOTW. The selection of a management option will depend on regulatory considerations, characteristics of the treated ground water, availability of a management option, and local considerations about the use of the treated ground water.

If treatment facilities will be constructed and operated for radioactive waste as part of an environmental restoration project (e.g., rather than using existing facilities on or off site), project managers must ensure that the requirements for new facilities (e.g., facility design) specified in the DOE Order must be met.

TRU treatment requirements are contained under Sections III (M)(2)(d&e), III (N), III(O) and II(Q)(3) of DOE Order M 435.1-1; Instrumentation and Control Systems, Storage, Treatment, and Monitoring requirements, respectively. [http://www.explorer.doe.gov:1776/htmls/currentdir.html]

For example, TRU waste treatment facilities must provide engineering controls and monitoring and/or leak detection capabilities to prevent spills and monitor waste inventory, and for detection of failed waste containment and/or other abnormal conditions. Detailed monitoring requirements for TRU storage facilities are defined under Section III (Q)(3) (Monitoring) of DOE Order M 435.1-1. These additional provisions require that facilities storing liquid TRU monitor liquid levels and/or waste volumes, along with significant waste chemistry parameters.

LLW treatment requirements are contained under Section IV (O) and under related Sections IV (M)(2)(b) (Site evaluation and design), IV (M)(2)(d&e) (LLW Treatment and Storage Design), IV (N)(1) (Storage and Staging), IV (N)(6) (Storage Management), and IV(R)(2) (Monitoring).

4.4.3 Package Requirements for Radioactive Wastes

If wastes will be shipped, appropriate packaging requirements will need to be used. Packaging requirements are generally appropriate for residuals generated from treating ground water rather than the treated ground water itself.

TRU wastes must be packaged so that containment and protection of the waste are provided for the duration of the projected storage period and until the waste is disposed or removed from the container. TRU packaging must prevent pressurization or generation of reactive, explosive, or flammable gases within waste containers must be used. Containers of TRU must be inspected and maintained to ensure that package integrity is not compromised. In addition, defense waste must be separated from non-defense waste during packaging to the extent that it is feasible.

LLW packaging requirements are contained in Section IV (L)(1)(a-c) (Packaging and Transportation) of DOE Order M 435.1-1.

LLW also must be packaged in a manner that provides containment for the duration of the anticipated storage period and until disposal. When the LLW is packaged, the waste must be documented, marked, and labeled to identify the contents of the package and for reporting on the waste manifest. Safety measures such as vents and aeration devices should be used on waste packages if the potential exists for pressurization or generation of flammable or explosive concentrations of gases within the waste container.

4.4.4 Disposal Requirements

TRU packaging requirements are outlined in DOE Order M 435.1-1, Sections III(L)(1)(a-d) (Packaging and Transportation) and III (N)(3) (Storage Container Inspection). External radiation levels for packages can not exceed 200 millirem per hour of contact (49 CFR 173.441).

Following any treatment, ground water that was contaminated with radionuclides can be disposed by methods such as reinjection to the aquifer or discharge. In either case, site- or unit-specific requirements will govern the conditions under which the disposal will occur.

4.5 Basic Management Requirements During Pre-Treatment, Treatment, and Post-Treatment Phases for Mixed Waste

Mixed hazardous and radioactive wastes are subject to the requirements of both RCRA (or the corresponding State program) and the requirements of DOE radioactive waste management orders. The requirements under each of these legal and regulatory programs are specified in Sections 4.3 and 4.4 of this chapter.

A November 6, 1998, Federal Register notice (63 FR 59989) extended EPA's policy of using enforcement discretion when enforcing the RCRA Section 3004(j) storage prohibition for mixed wastes. This allows mixed wastes, prohibited from land disposal, to continue to be stored as long as there are no available options for treatment of disposal.

There are very few specific mixed waste requirements specified in Federal or State law because the authority to regulate these wastes is split between different agencies and authorities (with each authority establishing requirements for its portion of the waste). In some cases, however, provisions of regulations do provide special accommodations for mixed wastes. For example, different time frames and approaches to regulation are often in effect for mixed wastes that are subject to RCRA land disposal restrictions because a shortage of management capacity has led EPA to issue some extension to effective dates or adopt modified enforcement strategies. Mixed waste residuals that are generated from treatment of ground water, therefore, may not currently be subject to LDR requirements even though an LDR treatment standard is in effect for the corresponding RCRA waste code.

4.6 Alternate Compliance Options

Several compliance options exist that project managers can use to overcome barriers associated with management of contaminated ground water. These options include:

4.6.1 Determination that hazardous wastes are no longer hazardous wastes;
4.6.2 ARAR waivers;
4.6.3 Temporary units;
4.6.4 Remedial Action Plan (RAP); and
4.6.5 RCRA Section 3020 exemption.

Two other waivers – use of alternate concentration levels and determination of technical impracticability – directly apply to ground water that is environmental restoration waste. However, rather than alternative management approaches, these waivers provide project managers with approaches to setting alternate cleanup levels for an aquifer.

4.6.1 Determination That Wastes are No Longer Hazardous Wastes

Hazardous wastes may be managed as non-hazardous if it is demonstrated that after treatment for hazardous materials, extracted ground water does not contain levels of hazardous constituents that require further management as a hazardous waste. Generally, EPA guidance establishes the levels as health-based levels, based on the contained-in policy (see Chapter 3).

Radioactive wastes are no longer subject to the requirements of DOE Order 435.1 when they no longer require management for their radioactive content. This will require a waste stream-specific evaluation to determine the nature of a treated (or untreated) liquid waste to evaluate whether it is still subject to management requirements.

4.6.2 ARAR Waivers

Additional information concerning ARARs can be found in DOE's *Compendium of Applicable or Relevant and Appropriate Requirements: Quick Reference Fact Sheets and Directives* (CERCLA)-005/1019.

Under CERCLA remedies, field managers can seek an exemption from clean-up standards by invoking an ARAR waiver. The restrictions on invoking waivers are codified in 40 CFR 300.430. ARAR waivers are generally granted for the following reasons:

- Compliance will create a greater risk to human health or the

environment;
- Technical impracticability;
- An alternative can result in an equivalent standard of performance;
- The state has inconsistently applied the requirement; or
- The action is an interim measure.

For example, see *Presumptive Response Strategy and Ex-situ Treatment Technologies for Contaminated Ground Water at CERCLA Sites*, October 1996, EPA 540/R-96/023.

Extensive EPA information exists on obtaining a technical impracticability waiver for ground water. For example, EPA has recently issued its presumptive response strategy for ground water.

4.6.3 Temporary Units

Temporary units (40 CFR 264.552) and corrective Action Management Units (CAMUs) (40 CFR 264.553) were promulgated jointly and provide regulatory flexibility when managing environmental restoration wastes. Generally, CAMUs are not useful for the remediation of contaminated ground water, but temporary units may be appropriate to consider.

A TU, however, may be useful in facilitating treatment of contaminated ground water. The advantages of using a TU are that the ground water can be stored for a longer period of time before treatment, and the tank or storage container does not have to meet strict requirements for secondary containment. Using TUs to store extracted ground water can reduce the costs of storage containers, allow for the actualization of economies of scale when selecting off-site treatment options, and provide greater flexibility in the timing of ground-water treated or disposed of on site.

4.6.4 Remedial Action Plans

EPA developed regulations allowing remedial action plans (RAPs) with six objectives in mind:

EPA established RAP under the new HWIR-Media rule (63 FR 65873, November 30, 1998).

1. RAPs should be suited to the specifics of managing remediation waste in the context of cleanup, both in procedure and in substantive requirements;

2. RAPs should ensure compliance with the applicable requirements for safe hazardous remediation waste management;

3. RAPs should provide certainty and protection to the permitted party, as appropriate;

4. the RAP approval process should provide opportunities for meaningful public involvement;

5. because RAPs constitute RCRA permits, the RAP approval

process must, at the least, follow the statutory minimum requirements for obtaining a permit; and

6. RAPs, and the RAP approval process should accomplish the previous objectives through the most streamlined, reasonable, and understandable regulations possible.

The RAP requirements:

- significantly reduce procedural steps in permitting, while retaining the minimum statutory public participation requirements and certain basic permitting steps or conditions (for example, permit appeal procedures);
- replacing the detailed requirements of §§ 270.3-270.66 with broader performance standards;
- significantly reducing and focusing information requirements; and
- removing the requirement for facility-wide corrective action.

RAPs are limited to the treatment, storage, or disposal of hazardous remediation wastes. As the preamble to the HWIR media rule discusses, the definition of remediation waste is limited to wastes that are managed to implement cleanup. **This definition does not include "as-generated" process waste or wastes from any activities that are not specifically implemented for the purposes of cleanup**.

4.6.5 RCRA Section 3020 Exemption

EPA has developed an exemption for the reinjection of contaminated ground water. Under RCRA Section 3020(a), disposal of hazardous waste into or above a formation that contains an underground source of drinking water is generally prohibited. RCRA Section 3020(b) provides an exception for underground injection carried out in connection with certain remediation activities. Under RCRA Section 3020(b), injection of contaminated ground water back into the aquifer from which it was withdrawn is allowed if (1) such injection is conducted as part of a response action under Section 104 and 106 of CERCLA or a RCRA corrective action intended to clean up such contamination; (2) the contaminated ground water is treated to substantially reduce hazardous constituents prior to reinjection; and, (3) the response action or corrective action will, on completion, be sufficient to protect human health and the environment. Approval of reinjection under RCRA Section 3020(b) can be included in approval of other cleanup activities, for example, as part of approval of a RCRA Statement of Basis or CERCLA Record of Decision.

For more information on the exemption for reinjection of contaminated ground water, see RCRA Section 3020(b), OSWER Directive 9234.1-06, *Applicability of Land Disposal Restrictions to RCRA and CERCLA Ground Water Treatment Reinjection Superfund Management Review: Recommendation No. 26*, November 27, 1989.)

Two other variances exist that may affect the management of remediation waste:

- RCRA technical impracticability waiver
- Alternate Concentration Limits

4.6.6 RCRA Technical Impracticability

The RCRA proposed Subpart S § 264.525 (d)(2)(iii) requirements [withdrawn October 7, 1999, 64 FR 54604] allowed the Regional Administrator to determine that media cleanup standards do not need to be met when remediation is technically impracticable. A RCRA determination of technical impracticability can be made where the "nature of the waste and the hydrogeologic setting would prevent or limit the effectiveness of a pump-and-treat system", or when remediation may be "possible but the scale of operations required might be of such a magnitude and complexity that the alternative would be impracticable" (55 Federal Register 30830, July 1990). It should be noted that a waiver for technical impracticability does not relieve the site of ultimate responsibility for the contaminated media.

For more information refer to, *Technical Impracticability Decisions for Ground Water at CERCLA Response Action and RCRA Corrective Action Sites*, DOE/EH-413/9814, August, 1998, [http://www.eh.doe.gov/oepa/ under "Policy and Guidance"].

4.6.7 Alternative Concentration Limits (ACLs)

ACLs are intended to provide flexibility in establishing ground-water cleanup levels. Under CERCLA, ACLs can be used as the media cleanup standard in place of MCLs if the following criteria are met:

- The ground water has known or projected points of entry into surface waters;
- There are no "statistically significant" increases of contaminant concentrations in the surface water at the point of discharge downstream; and
- Institutional controls can be reliably used to prevent human exposure to the contaminated ground water. [CERCLA §121(d)(2)(B)(ii)]

ACLs can be used under both CERCLA and RCRA remediations but are interpreted differently under the two statutes. More information concerning ACLs can be found in EPA OSWER Directive 9283.1-2, 1988 and in *Use of Alternate Concentration Limits (ACLs) to Determine Cleanup or Regulatory Levels Under RCRA and CERCLA*, DOE/EH-413-9912-1, December, 1999, [http://www.eh.doe.gov/oepa/ under "Policy and Guidance"].

If an ACL is established then an ARAR waiver will not be required.

In the existing RCRA Subpart F requirements, ACLs are one of three methods allowed for developing concentration levels for contaminants in ground water. The factors that the Regional Administrator must consider in establishing ACLs are extensive and are listed in 40 CFR 264.94 (b). Unlike the use of ACLs under CERCLA remediations, RCRA does not limit ACLs to cases where ground water discharges to surface waters.

Although the nomenclature of ACLs is not specifically used in the proposed Subpart S regulations, they do allow the Regional Administrator to develop “alternate measures” to protect human health and the environment if:

- The contamination originated from a source other than a Solid Waste Management Unit (SWMU);

- The ground water is not a potential source of drinking water; and is not hydraulically connected with waters where the constituent would exceed an action level; or

- Remediation is technically impracticable. (55 FR 30878, July 1990)

Chapter 6
Management of Contaminated Debris During Environmental Restoration Actions

This chapter summarizes the primary technical and regulatory requirements for the treatment, storage, and disposal of contaminated debris when it is an environmental restoration waste. It also provides an overview of the options for managing contaminated debris. Types of debris waste covered in this section include hazardous, radioactive, and mixed wastes as well as other types of debris such as PCBs and asbestos-containing waste. It is organized in the sections shown in Exhibit 6-1.

This chapter is organized differently than Chapters 4 and 5 because unique handling requirements exist for hazardous debris.

Exhibit 6-1
Summary of Chapter Sections

Section	Summary of Contents
6.1 Summary of Major Requirements (page 6-1)	A summary of the major requirements associated with managing hazardous, radioactive, and mixed waste debris.
6.2 Concepts and Definitions (page 6-2)	Provides key definitions needed to comply with debris requirements.
6.3 Management Options for Hazardous Debris (page 6-3)	Describes two options for managing hazardous debris: (1) meeting LDR treatment standards; or (2) meeting alternate debris-specific standards. Also describes how to manage treatment residues and requirements for facilities treating debris.
6.4 Management of Radioactive, Mixed Waste, and Other Types of Debris (page 6-10)	Describes requirements for radioactive, mixed waste, PCB, and asbestos debris.
6.5 Exemptions for Managing Debris (page 6-13)	Describes available exemptions for managing contaminated debris.

6.1 Summary of Major Requirements

The following are the major requirements and approaches for managing debris when it is an environmental restoration waste:

- Mixtures of debris and other materials, such as soil or sludge, are regulated as debris if the mixture is comprised primarily of debris (by volume) based on visual inspection. A distinction project managers will need to make early when managing debris is whether it will be subject to RCRA or an equivalent State hazardous waste program (i.e., because it is a hazardous waste or contains a hazardous waste), is radioactive, or is another regulated type of debris (e.g., PCB, asbestos-containing). If debris is not hazardous or radioactive waste, it generally can be managed as solid waste in accordance with generally much less stringent State or local industrial waste, construction waste, or other non-hazardous waste requirements.

- The primary drivers for management of debris that is hazardous are the RCRA LDR requirements. These regulations provide debris-specific treatment requirements that apply when hazardous debris is generated during a remediation action and land disposed.

The debris-specific RCRA LDR requirements are promulgated at 40 CFR 268.45.

- In several cases (such as when specified decontamination approaches are used for non-porous debris), once LDR treatment standards are met for hazardous debris, the debris is no longer subject to RCRA hazardous waste requirements.

- Debris that is contaminated with radioactive materials[1] is subject to DOE Orders for waste management. In addition, its management requirements are often determined by any health and safety or worker or public dose requirements. Establishing that debris is no longer radioactive waste requires a case-by-case evaluation of the debris and its contaminants against a variety of policies and procedures because a single, promulgated “below regulatory concern” or “non-contaminated level” does not exist for radioactively contaminated materials.

For example, see DOE Order 5400.5 for generic unconditional release criteria for surface contamination. For an example of determining when debris is no longer considered subject to radioactive waste requirements, see *Draft Handbook for Controlling Release for Reuse or Recycling of Non-Real Property Containing Residual Radioactive Material*, June, 1997, [http://www.eh.doe.gov/oepa/ under “Policy and Guidance”].

- Mixed waste debris is subject to both the RCRA and radioactive waste requirements. This may require compliance with both the LDR treatment requirements and consideration of radioactive waste facility WAC.

See http://www.eh.doe.gov/oepa/ under “Policy and Guidance” for more information on determining how to manage PCB and asbestos materials.

- PCB and asbestos-containing materials are managed consistent

[1] NOTE: On January 12, 2000, the Secretary of Energy placed a moratorium on the Department’s release of volumetrically contaminated metals pending a decision by the Nuclear Regulatory Commission (NRC) whether to establish national standards [News Release – Energy Secretary Richardson Blocks Nickel Recycling at Oak Ridge]. Therefore, the Department will not allow the release of scrap metals for recycling if contamination from DOE operations is detected using appropriate, commercially available monitoring equipment and approved procedures. Consequently, the unrestricted release for recycling of scrap metals from radiation areas is suspended until improvements in release criteria and information management have been developed and implemented. Additionally, on July 13, 2000, the Secretary [Secretarial Memorandum-Release of Surplus and Scrap Materials] directed further action in four areas: (1) improvement of the Department’s release criteria and monitoring practices; (2) expansion of efforts to promote reuse and recycling within the complex of DOE facilities; (3) improvement of the Department’s management of information about material inventories and releases; and, (4) the accelerated recovery of sealed sources as described in the July 13, 2000, Secretarial memorandum. While updated release criteria and record keeping procedures are being developed and implemented, the Department will undertake several activities to promote internal reuse and recycling. Finally, when revised directives and guidance are in place, the Department will require each DOE site to have local public participation before the site may resume the unrestricted release for recycling of scrap metals from radiation areas.

with other PCB and asbestos-containing wastes, namely in accordance with TSCA requirements for what levels must be attained and how they must be disposed.

6.2 Concepts and Definitions

There are several key concepts and definitions critical to understanding how to manage hazardous debris. The main regulatory drivers for managing hazardous debris are the LDRs and the "contained-in" policy for debris. The LDRs apply to debris that is contaminated with either a listed or characteristic hazardous waste. The LDR regulations for debris begin with the following definitions:

For definitions of listed and characteristic hazardous wastes and the contained-in policy, see Chapter 3 of this *Guide*: Characterization of Environmental Restoration.

Debris means any solid material exceeding a 60 mm particle size that is intended for disposal and that is either a manufactured object, plant or animal matter, or natural geologic material. A mixture of debris that has not been treated to the standards provided by 40 CFR 268.45 and that contains other material is subject to regulation as debris if the mixture is comprised primarily of debris, by volume, based on visual inspection [40 CFR 268.2(g)].

EPA has identified several commonly encountered types or categories of debris. These include glass, metal, plastic rubber, brick, cloth, concrete, paper, pavement, rock, and wood.

Hazardous debris means debris that contains a hazardous waste listed in Subpart D of Part 261, or that exhibits a characteristic of hazardous waste identified in Subpart C of Part 261 [40 CFR 268.2(h)].

The following materials are specifically excluded from the definition of debris:

- Any material for which a specific treatment standard is provided in Subpart D of 40 CFR Part 268, namely lead acid batteries, cadmium batteries, and radioactive lead solids;
- Process residuals such as smelter slag and residues from the treatment of waste, wastewater, sludges, or air emission residues; and
- Intact containers of hazardous waste that are not ruptured and that retain at least 75% of their original volume.

Intact containers of hazardous waste are not considered debris and are regulated under 40 CFR 261.7.

6.3 Management Options for Hazardous Debris

Project managers have two available options for managing hazardous debris when it is generated as environmental restoration waste and is subject to the RCRA LDR treatment standards: (1) treat the debris to meet the LDR waste-specific treatment standards for the waste or wastes contaminating the debris, or (2) treat the debris using the appropriate alternative treatment standard promulgated at 40 CFR 268.45. Under the second option, project managers also have a possibility of having the treated debris no longer be considered hazardous waste subject to RCRA Subtitle C standards as a result of the contained-in interpretation.

Treatment standards for each kind of debris (e.g., concrete, metal) and each contaminant found in a mixture of debris types must be met unless the debris is converted into a treatment residue as a result of the treatment process. Debris treatment residues are subject to the waste-specific treatment standards for the waste contaminating the debris. For example, any lead dust removed from concrete through scabbling must, in turn, be evaluated for RCRA compliance and managed in accordance with the appropriate treatment standard for lead (not lead-contaminated concrete).

If reducing the particle size of the debris to meet the treatment standards results in material smaller than the 60 mm particle size limit for debris, this material is subject to the waste-specific treatment standards for the waste contaminating the material, unless the debris has been cleaned and separated from contaminated soil and waste prior to size reduction. At a minimum, simple physical or mechanical means must be used to provide such cleaning and separation of non-debris materials to ensure that the debris surface is free of caked soil, waste, or other non-debris material.

6.3.1 Option 1: Meet Waste-Specific Treatment Standards

Waste-specific treatment standards are promulgated in 40 CFR Parts 268.41 and 268.43.

The first option for managing hazardous debris is to treat the debris to meet the existing LDR treatment standards for the waste or wastes contaminating the debris. These waste-specific treatment standards are promulgated in 40 CFR §§268.41 and 268.43 for each hazardous waste. Debris may not be land disposed if the contaminant levels, for which it has been treated, exceed these waste-specific standards.

This option may only be utilized for debris contaminated with a listed waste. If this option is selected, the derived-from rule continues to apply to the debris (and any residues generated) after treatment. This means that debris contaminated with a listed waste would still carry the listed code after treatment and thus would be subject to RCRA Subtitle C regulations.

(Note: Debris contaminated by a characteristic waste must be treated to the alternative treatment standards using one of the extraction, destruction, or immobilization technologies listed in Exhibit 6-2.)

6.3.2 Option 2: Meet Alternative Treatment Standards

The second option for managing hazardous debris is the use of alternative treatment standards that EPA has promulgated at 40 CFR 268.45. These treatment standards are an alternative to the waste-specific treatment standards promulgated in 40 CFR §§268.41 and 268.43. EPA established these alternative treatment standards, which are based on using specified technologies to meet existing waste-specific standards, because it is often too difficult to get a representative sample of debris for waste characterization.

Seventeen treatment technologies are BDAT for hazardous debris, falling into three general categories: extraction, destruction, and immobilization.

Required BDAT for treating hazardous debris include: extraction, destruction and immobilization.

- *Extraction technologies* are subdivided into three groups - physical, chemical, and thermal.
- *Destruction technologies* include biodegradation, chemical oxidation, chemical reduction, and thermal destruction.
- *Immobilization technologies* include macroencapsulation, microencapsulation (stabilization), and sealing.

To ensure effective treatment of the debris, the treatment must be conducted in accordance with specified performance and/or design and operating standards. The performance and/or design and operating standards must be met for all debris surfaces that are contaminated with a hazardous waste. The alternative treatment standards for hazardous debris are outlined in Exhibit 6-2.

Regulations for delisting hazardous debris after it has been treated using an approved extraction or destruction treatment technology are codified in 40 CFR 261.3(f)(1).

Under Option 2, most characteristic and/or listed hazardous debris can be treated using specific treatment technologies. Debris that is hazardous because it exhibits an ICR characteristic (i.e., ignitability, corrosivity, or reactivity) must be treated to deactivate the characteristic using one of the technologies identified in Exhibit 6-2. In actual practice, this constraint may be of little concern because almost no debris will be ignitable (because most ignitable wastes are liquids) and no debris will be corrosive (because corrosive wastes are either aqueous or liquid).

Debris that exhibits the characteristic of reactivity from the presence of cyanide must be treated to the waste-specific cyanide standards in 40 CFR 268.43. If debris is hazardous because it exhibits the characteristic of toxicity, the debris must be treated to meet the standards set forth in the toxicity characteristic leaching procedure.

Debris contaminated with a listed hazardous waste that has not been treated to the waste-specific standards in either 40 CFR §§268.41 or 268.43 must be treated using the alternative treatment standards specified in Exhibit 6-2. EPA has established that the alternative treatment standards may be used, regardless of whether the listed waste has concentration-based or specified-method treatment standards.

Exhibit 6-2
Alternative Treatment Standards for Hazardous Debris

Technology	Performance and/or Design and Operating Standard	Contaminant Restrictions
	EXTRACTION TECHNOLOGIES	
***Physical Extraction*:** includes abrasive blasting; scarification, grinding, and planing; spalling; vibratory finishing; and high-pressure steam and water sprays.	***Glass, metal, plastic, rubber:*** Treat to clean debris surface. ***Brick, cloth, concrete, paper, pavement , rock, wood:*** Remove at least 0.6 cm of the surface layer and treat to a clean debris surface.	***All debris:*** None.
Chemical Extraction: includes water washing and spraying, liquid-phase solvent extraction, vapor-phase solvent extraction.	***All debris:*** Treat to a clean debris surface. ***Brick, cloth, concrete, paper, pavement , rock, wood:*** Debris must be no more that 1.2 cm in one dimension, except that this thickness limit may be waived under an "Equivalent Technology" approval under §268.42(b); debris surfaces must be in contact with the water solution for at least 15 minutes. (With vapor-phase solvent extraction: same as above except that debris surfaces must be in contact with the organic vapor for at least 60 minutes.)	***Brick, cloth, concrete, paper, pavement , rock, wood:*** Contaminant must be soluble to at least 5% by weight in water solution or by 5% by weight in emulsion; if debris is contaminated with a dioxin-listed waste, an "Equivalent Technology" approval under §268.42(b) must be obtained. (With liquid-phase solvent extraction: same as above except that contaminant must be soluble to at least 5% by weight in the solvent.)
Thermal Extraction: includes high-temperature metals recovery and thermal desorption.	High-temperature metals recovery: ***For refining furnaces,*** treated debris must be separated from treatment residues using simple physical or mechanical means. Prior to further treatment, such residue must meet the waste-specific treatment standards for organic compounds in the waste contaminating debris. Thermal desorption: ***All debris:*** Same as above; and must obtain an "Equivalent Technology" approval under §268.42(b). ***Brick, cloth, concrete, paper, pavement , rock, wood:*** Debris must be no more than 10 cm in one dimension, except that this thickness limit may be waived under an "Equivalent Technology" approval under §268.42(b).	High-temperature metals recovery: ***Debris contaminated with a dioxin-listed waste:*** Obtain an "Equivalent Technology" approval under §268.42(b). Thermal desorption: ***All debris:*** Metals other than mercury.

Technology	Performance and/or Design and Operating Standard	Contaminant Restrictions
DESTRUCTION TECHNOLOGIES		
Biological Destruction: includes biodegradation only.	***All debris:*** Obtain an "Equivalent Technology" approval under §268.42(b); treated debris must be separated from treatment residues using simple physical or mechanical means, and, prior to further treatment, such residue must meet the waste-specific treatment standards for organic compounds in the waste contaminating debris. ***Brick, cloth, concrete, paper, pavement , rock, wood:*** Debris must be no more that 1.2 cm in one dimension, except that this thickness limit may be waived under an "Equivalent Technology" approval under §268.42(b).	***All debris:*** Metal contaminants.
Chemical Destruction: includes chemical oxidation and chemical reduction.	Same as above.	Same as above.
Thermal Destruction	***Treated debris*** must be separated from treatment residues using simple physical or mechanical means, and, prior to further treatment, such residue must meet the waste-specific treatment standards for organic compounds in the waste contaminating debris.	***Brick, concrete, glass, metal, pavement, rock:*** Metals other than mercury, except that there are no metal restrictions for vitrification. ***Debris contaminated with dioxin-listed waste:*** Obtain an "Equivalent Technology" approval under §268.42(b), except that this requirement does not apply to vitrification.
IMMOBILIZATION TECHNOLOGIES		
Macroencapsulation	***Encapsulating material*** must completely encapsulate debris and be resistant to degradation by the debris, its contaminants, and materials into which it may come into contact after placement.	None.
Microencapsulation	***Leachability*** of the hazardous contaminants must be reduced.	None.
Sealing	***Sealing*** must avoid exposure of the debris surface to potential leaching media, and sealant must be resistant to degradation by the debris, its contaminants, and materials with which it may come into contact after placement.	None.

Debris that is contaminated with two or more hazardous contaminants must be treated for each contaminant using one or more of the treatment technologies identified in Exhibit 6-2. If an immobilization technology is used in a treatment train, it must be the last treatment technology used.

The alternative treatment standards presented in Exhibit 6-2 must be achieved for each type of debris contained in a mixture of debris types. Again, if an immobilization technology is used in a treatment train, it must be the last treatment technology used.

Mixtures containing more than one type of debris, or more than one contaminant, must be treated to meet the standards for each contaminant and each type of debris. If a single technology is not appropriate for all contaminants and debris types present in the mixture, a sequential treatment train must be used. If an immobilization technology is used in the treatment train, it must be the last treatment technology used.

The LDR regulations prohibit the use of some technologies to treat specific types of contaminants. Generators and treaters of hazardous debris may select any treatment technology in Exhibit 6-2 that is not restricted for the contaminant subject to treatment, as indicated in the third column of the exhibit.

In some cases, EPA was not able to establish performance and/or design and operating requirements for a particular extraction or destruction technology listed in Exhibit 6-2 that would be entirely protective of human health and the environment. This subject became a particular point of concern because it meant that treated debris may no longer be governed by Subtitle C controls. In such cases, the alternative treatment standards require the owner or operator of the treatment unit to make an "equivalency demonstration." To fulfill these requirements, the facility operator must:

Regulations for equivalency demonstrations are codified in 40 CFR 268.42(b).

1. Document that the technology being used treats the contaminants to a level equivalent to the other technologies specified in Exhibit 6-2, and

2. Show that residual levels of hazardous contaminants may not pose a hazard to human health and the environment, absent RCRA Subtitle C regulatory control.

Generators and treatment facility operators can also attempt to make a similar demonstration for an alternative treatment technology not listed in Exhibit 6-2. If the generator or treater shows the alternative technology performs as well as the technology specified in Exhibit 6-2, EPA or an authorized state can approve use of the alternate technology.

After the hazardous debris has been treated, it may be land disposed. **If the debris is treated using an approved extraction or destruction technology, it will not have to be managed as a hazardous waste and, therefore, may be disposed of in a Subtitle D (solid waste) facility**. However, hazardous debris contaminated with a listed waste that is treated with an immobilization technology must be disposed of in a Subtitle C (hazardous waste) facility. This debris is not excluded from Subtitle C regulation because contaminants are not removed or destroyed during immobilization; they are simply contained indefinitely.

6.3.3 Treatment Residues

Residues from the treatment of hazardous debris (e.g., dusts, materials extracted from debris) must be separated from the debris using simple physical or mechanical means. The separation process does not need to produce a "clean debris surface." The debris surface must only be free of caked residues or non-debris material, such as soil or waste. These residues are then subject to the waste-specific treatment standards for the waste contaminating the debris.

An extensive definition of "clean debris surface" can be found in 40 CFR 268.45.

The residues from treated debris contaminated with listed hazardous wastes remain hazardous unless they are delisted via a site-specific delisting petition. If the residues are not separated from the treated debris, the debris remains a hazardous waste and must be disposed of in a Subtitle C (hazardous waste) facility.

The LDR regulations for hazardous debris include special requirements for three types of treatment residues:

LDR regulations for hazardous debris include requirements for non-hazardous residues from ignitable, corrosive or reactive characteristic debris, residue from debris that is reactive due to contact with cyanide, and ignitable non-waste water residues containing less than or equal to 10% total organic content (TOC).

1. Residues from the treatment of ignitable, corrosive, or reactive characteristic debris, not contaminated with a prohibited listed hazardous waste, cyanide, or a toxic constituent, must be deactivated prior to land disposal.

2. Residues from the treatment of debris that is reactive because of cyanide must meet the treatment standards for D003 reactive cyanide waste promulgated in 40 CFR 268.43.

3. Ignitable non-wastewater residues containing $\geq$ 10% total organic content (TOC) are subject to the technology-based standards for D001 wastes. In other words, ignitable residues must be treated to recover organic constituents, incinerated, substituted for fuel in a boiler or industrial furnace, or treated by non-combustive high-temperature organic destruction.

6.3.4 Facility Standards Applicable During Hazardous Debris Treatment

Treatment of hazardous debris (other than in 90-day accumulation units) is currently subject to the applicable interim status and permit standards of 40 CFR Parts 264, 265, 266, and 270. Existing facility standards that are likely to apply to common debris treatment options are:

In some cases, treatment conducted in tanks may be eligible for the wastewater treatment unit exemption codified in §§264.1(g)(6), 265.1(c)(10), and 270.1(c)(2)(v).

1. Debris treatment conducted in tanks, such as high-pressure steam and water spraying, chemical extraction, and biodegradation, is subject to the tank standards in Subpart J of 40 CFR Parts 264 and 265.

2. Debris treatment conducted in incinerators is subject to Subpart O of 40 CFR Parts 264 and 265.

3. Debris treatment conducted in high temperature metals recovery (HTMR) furnaces is conditionally exempt from the Boiler and Industrial Furnace (BIF) regulations in 40 CFR Part 266, Subpart H.

4. Debris treatment conducted in thermal desorbers and thermal destruction units is subject to either the incinerator standards (40 CFR Parts 264 and 265, Subpart O) or the thermal treatment standards (40 CFR Part 264, Subpart X or Part 265, Subpart P).

EPA has also established its position on permit requirements during decontamination of a building prior to demolition, and on the holding of removed contaminants within the building. This situation arises when physical extraction technologies are used to treat debris in place. EPA ruled that an intact building that is scheduled to be discarded is technically not yet a solid waste, and therefore, physical extraction of contaminants would not constitute hazardous waste treatment.

If the storage conditions of 40 CFR 262.34 are met, the waste may be accumulated for up to 90 days without a permit.

Where hazardous debris treatment does require a permit, temporary authorizations can be obtained to conduct short-term treatment or storage activities. EPA may grant temporary authorizations, for up to 180 days, that may be renewed once. To obtain a temporary authorization, facility owners or operators must demonstrate compliance with the applicable 40 CFR Part 264 standards and must specifically meet the criteria of 40 CFR 270.42(e).

6.4 Management of Radioactive, Mixed Waste, and Other Types of Debris

Five types of debris may pose unique regulatory concerns: asbestos debris, inherently hazardous debris, PCB-contaminated debris, radioactive debris, and mixed waste debris. The regulations applicable to these unique types of debris are summarized below.

6.4.1 Asbestos Debris

The treatment standards for hazardous debris also apply to asbestos debris. EPA acknowledges that many of the treatment technologies identified in Exhibit 6-2 are not practical for treating asbestos debris because workers may be exposed to the asbestos particles or because asbestos may be released to the environment. However, EPA believes that several of these treatment technologies can be used to treat asbestos-containing debris in compliance with applicable Occupational Safety and Health Administration (OSHA), National Emission Standards for Hazardous Air Pollutants (NESHAP), and TSCA standards if filtration devices are used to control air and water emissions.

See *Regulatory Requirements Affecting Disposal of Asbestos-Containing Waste,* EH-413-062/1195, November 1995, found at: [http://www.eh.doe.gov/oepa/ under "Policy and Guidance"].

6.4.2 Inherently Hazardous Debris

Inherently hazardous debris is debris that, even after decontamination, fails the TCLP because of inherent metal content (e.g., lead pipes). On January 9, 1992, EPA proposed that debris fabricated from D004-D011 metals that exhibits both the TCLP and Extraction Procedures (EP) toxicity characteristics as fabricated should either be immobilized, disposed of in a hazardous waste landfill, or recycled (e.g., as scrap metal). If the inherently contaminated debris also contains other contaminants subject to treatment, it must be treated for those contaminants first (prior to being immobilized or recycled).

A discussion on EPA's inherently hazardous debris rule and how it relates to scrap metal, can be found in 57 FR 37237 (August 1992).

6.4.3 PCB-Contaminated Debris

PCB-contaminated debris is already subject to decontamination and/or disposal requirements promulgated under TSCA and codified in 40 CFR §§761.60 and 761.125. Hazardous debris that is also a PCB waste is subject to both RCRA and TSCA regulations. Persons treating or disposing of these wastes must satisfy those requirements which are more stringent.

See http://www.eh.doe.gov/oepa/ "Policy and Guidance" for information briefs sheets on managing PCBs.

6.4.4 Radioactive Debris Requirements

Debris that is contaminated solely with radionuclides must be managed as radioactive waste in accordance with the *Atomic Energy Act* of 1954, as amended and DOE Orders for Radioactive Waste Management (i.e., DOE O 435.1 and DOE M 435.1-1). For project managers of environmental projects that generate radioactively contaminated debris,

DOE Order 5820.2A for Radioactive Waste Management is replaced by DOE Order 435.1. [http://www.explorer.doe.gov:1776/htmls/currentdir.html].

the waste acceptance criteria, waste characterization, certification and transfer requirements of a facility to which debris will be sent for storage, treatment, or disposal often determine the specific considerations that must be a part of project planning.

See *Waste Acceptance Criteria for the Waste Isolation Pilot Plant*, April 1996 (DOE/WIPP-069, Revision 5 Chg. 2 December 1996).

According to DOE M 435.1, waste acceptance criteria must specify allowable activities or concentrations of specific radionuclides, package requirements, and any applicable restrictions that would impact waste handlers or compromise facility or package performance, among others. Sections III and IV (G)(1)(b&c) of DOE Order M 435.1-1 provide a full listing of the elements that must be specified for waste acceptance criteria for TRU and LLW facilities.

Waste acceptance criteria for TRU and LLW facilities are outlined in Sections III and IV (G)(b&c) of DOE Order M 435.1-1. Waste characterization, certification and transfer requirements are outlined in Sections III and IV (I, J & K) of DOE Order M 435.1-1.

A final consideration when considering radioactive debris requirements will be health and safety restrictions that, in turn, determine how radioactive wastes such as debris must be handled. For example, as outlined in the DOE Standard 1120-98, *Integration of Environment, Safety, and Health into Facility Disposition Activities*, projects including radioactive materials may trigger key nuclear safety and hazard analysis for all aspects of planned work and waste management.

Facility decommissioning is considered a CERCLA non-time critical removal action under a 1995 EPA/DOE memorandum of Understanding. Debris is commonly generated as part of decommissioning actions.

6.4.5 Mixed Waste Debris Requirements

Mixed wastes are those wastes that have both radioactive and hazardous components. The radioactive components of the waste are regulated under the *Atomic Energy Act* (AEA) of 1954, as amended, while the hazardous components are regulated under RCRA. These wastes pose particular problems under the RCRA program because few commercial facilities are permitted to accept mixed waste. Safety and health concerns associated with radioactive components also rule out many conventional hazardous waste management techniques.

On June 1, 1990, EPA promulgated treatment standards for four subcategories of mixed waste under 55 FR 22520 :

- Specific high-level wastes,
- D008 radioactive lead solids,
- Mixed wastes containing elemental mercury, and
- Mercury-containing hydraulic oil contaminated with radioactive materials.

Debris contaminated with one of these four categories of mixed waste does not meet the definition of debris and are therefore subject to the waste-specific treatment standards.

For more information on treatment standards for various categories of mixed waste, refer to 55 FR 22520, June 1990.

EPA also asserted that “all promulgated treatment standards for RCRA listed and characteristic wastes apply to the RCRA hazardous portion of mixed radioactive (high-level, transuranic, and low-level) wastes, unless EPA has specifically established a treatability group for that specific category of mixed waste." (55 FR 22520, June 1990).

Although hazardous debris that is, or contains, mixed waste is subject to the debris treatment standards, the definition of debris specifically excludes any material for which a specific treatment standard is provided in 40 CFR Part 268, Subpart D. Therefore, wastes in the four mixed waste subcategories mentioned in the previous paragraph do not meet the definition of debris, and as such, the waste-specific standards for hazardous and radioactive constituents apply.

6.5 Exemptions For Managing Debris[2]

Depending on the technology used to remove hazardous contaminants from certain waste materials and whether allowable radionuclide release limits have been established for materials managed at radioactive waste facilities, debris that is generated or collected during environmental restoration activities may be exempted from treatment as either a hazardous or radioactive substance. The demonstrations that must be met to earn such exemptions are listed below.

6.5.1 Hazardous Waste

In addition to setting treatment standards, the LDR regulations address the issue of when treated debris is a hazardous waste and when it is not. Debris may be excluded from Subtitle C regulations in two ways. First, the debris may be excluded if it is treated to meet the alternative treatment standards for debris by using an extraction or destruction technology listed in Exhibit 6-2 and if the treated debris does not exhibit a hazardous characteristic [see 40 CFR 261.3(f)(1)]. Treatment using an immobilization technology does not qualify a listed debris for exclusion because the contaminants are not removed or destroyed; they are simply contained indefinitely.

Second, debris contaminated with a listed hazardous waste can be excluded from Subtitle C regulation via a case-by-case basis determination by EPA that the debris no longer contains hazardous waste at significant levels [see 40 CFR 261.3(f)(2)]. Untreated debris and debris treated by a technology other than an extraction or destruction technology can be excluded in this manner. This determination will be made by EPA or authorized State. This approach,

Treatment by immobilization does not exempt debris from Subtitle C regulation.

More information on these policies and procedures may be found in *Draft Handbook for Controlling Release for Reuse and Recycling of Non-Real Property Containing Residual Radioactive Material*, June 1997, [http://www.eh.doe.gov/oepa/ under "Policy and Guidance"].

Many of these requirements are contained in draft regulations, 10 CFR 834, which, when promulgated, will codify many of the current policies in DOE Order 5400.5.

[2] See note on page 6-2.

in effect, codifies the Agency's "contained-in" policy as it relates to hazardous wastes that are contained in or mixed with debris.

6.5.2 Exemptions From Managing Debris as Radioactive Waste[3]

Debris is classified as a type of non-real property (as opposed to real property, such as land). Neither DOE or the Nuclear Regulatory Commission (NRC) have a single process to exclude radioactively contaminated non-real property from regulation as radioactive wastes. Previous attempts to establish "below regulatory concern" levels by the NRC were not successful. Therefore, DOE relies on both DOE Order 5400.5 (Radiation Protection of the Public and the Environment) and its implementing policy and guidance to establish processes and limits under which non-real property may be released for reuse or recycling.

In general, existing policy establishes 10 steps for evaluating whether materials can be released: (1) characterize and describe the non-real property proposed for release; (2) do release limits exist? (3) define release limits needed; (4) develop release limits; (5) compile and submit application for DOE Field Office approval; (6) document approved limits in public record; (7) implement approved limits; (8) conduct survey measurements; (9) does property meet limits? (10) release property.

Further, the guidance outlines that release limits are based on implementing an ALARA (as low as reasonably achievable) process, under which DOE considers alternatives involving different management approaches, developing dose calculations for maximally exposed individuals, and focusing on actual and likely use as well as worst plausible use.

In addition, as shown in Exhibit 6-3, DOE has put forth guidance that outlines surface activity guidelines, describing the allowable total residual surface activity in order to release non-real property.

Additional information on the use of ALARA principles is contained in Section IV (P)(2) of DOE Order M 435.1-1.

[3] See note on page 6-2.

Exhibit 6-3: Surface Activity Guidelines
Allowable Total Residual Surface Activity (dpm/100 cm^2)[2]
Source: *Response to Questions and Clarification of Requirements and Processes: DOR 5400.5, Section II.5 and Chapter IV Implementation Requirements Related to Residual Radioactive Material*, November 17, 1995

Radionuclides[3]	Average[4/5]	Maximum[6]/[7]	Removable[7]
Group 1 - Transuranics, 1-125, I-129, Ac-227, Ra-226, Ra-228, The-228, Th230, Pa-231	100	300	20
Group 2 - The-natural, Sr-90, I-126, I-131, I-133, Ra-223, Ra-224, U-232, The-232	1,000	3,000	200
Group 3 - U-natural, U-235, U-238, and associated decay products, alpha emitters	5,000	15,000	1,000
Group 4 - Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous[8] fission)	5,000	15,000	1,000
Tritium (applicable to surface and subsurface)[9]	N/A	N/A	10,000

[2]As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by counts per minute measured by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.
[3] Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides should apply independently.
[4] Measurements of average contamination should not be averaged over an area of more than 1 m^2. For objects of smaller surface area, the average should be derived for each such object.
[5] The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at 1 cm.
[6] The maximum contamination level applies to an area of not more than 100 cm^2.
[7] The amount of removable material per 100 cm^2 of surface area should be determined by wiping an area of that size with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wiping with appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm^2 is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. it is not necessary to use wiping techniques to measure removable contamination levels if direct scan surveys indicate that the total residual surface contamination levels are within the limits for removable contamination.
[8] This category of radionuclides includes mixed fission products, including the Sr-90 which is present in them. It does not apply to Sr-90 which has been separated from the other fission products or mixtures where the Sr-90 has been enriched.
[9] Property recently exposed or decontaminated, should have measurements (smears) at regular time intervals to ensure that there is not a build-up of contamination over time. Because tritium typically penetrates material it contacts, the surface guidelines group 4 are not applicable to tritium. The Department has reviewed the analysis conducted by the DOE Tritium Surface Contamination Limit Committee ("Recommended Tritium Surface Contamination Release Guides," February 1991), and has assessed potential doses associated with the release of property containing residual tritium. The Department recommends the use of the stated guideline as an interim value for removable tritium. Measurements demonstrating compliance of the removable fraction of tritium on surfaces with this guideline are acceptable to ensure that non-removable fractions and residual tritium in mass will not cause exposures that exceed DOE dose limits and constraints.